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PACIFIC NORTHWEST FOREST AND RANGE
EXPERIMENT STATION
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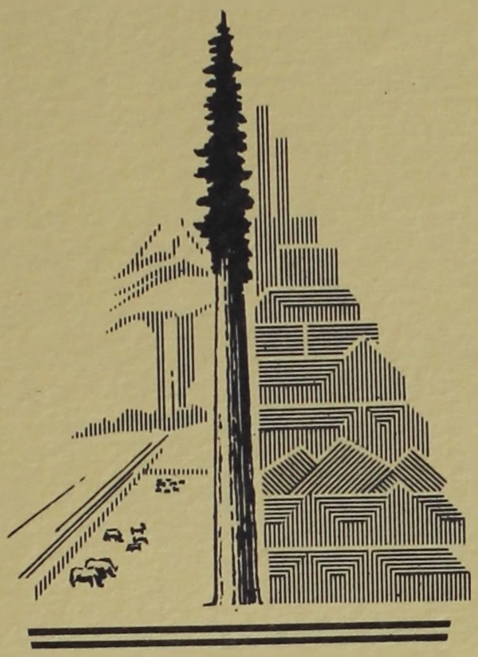
ANNUAL REPORT - 1953



U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
R. W. COWLIN, DIRECTOR

PORTLAND, OREGON

MARCH 1954

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ANNUAL REPORT OF THE PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION FOR THE CALENDAR YEAR 1953

INTRODUCTION

In all respects 1953 was a year of progress and accomplishment for the station. Resumption and expansion of research activity following World War II is showing positive results. Likewise rewards of critical program planning and review and strengthening of cooperative efforts are accumulating. Tangible expressions of these accomplishments are completion of many studies, a growing list of research publications, and promising progress on many other studies. Other events of 1953 improve the outlook for 1954. We can look forward confidently to a continuing flow of useful research findings for incorporation into progressive forest and range management practices.

We cannot be complacent or slacken our efforts for the job ahead is tremendous. Demand for research and its benefits is constantly expanding in the Pacific Northwest and completion of one research opens new fields of study. The problem of managing forest and range land becomes more complex as alternate and potentially conflicting uses develop and as utilization of timber and range products intensifies.

Previous reports have emphasized our inability to initiate adequate programs in several fields, notably forest genetics and watershed management. This inadequacy has not been remedied although modest progress has been made. As a beginning the major problems in forest genetics and watershed management are being identified and problem analyses are being prepared. These problems have been discussed at group and advisory committee meetings and their importance confirmed.

Review of going programs through administrative proceedings and through advisory group discussion and consultation is well along. During the past two years all research centers and experimental forest and ranges have been inspected by the director's office. Problem area analyses and study programs have been revised and overhauled, where needed. The Puget Sound and Deschutes Research Center Advisory Committees each met twice during 1953 giving valuable advice. The Siskiyou-Cascade Research Center committee was organized and held its first meeting at Roseburg on November 3. In addition, station personnel participated in meetings and work of various groups and committees involving research program planning in several subject-matter fields. The Regional Forest Service Advisory Council held a meeting at the Pringle Falls Experimental Forest. Among the subjects presented was the need for research in forest genetics and watershed management in the Pacific Northwest. A station technical advisory committee was organized and will meet initially February 1954.

The station, in common with Region 6 of the Forest Service, received a general integrating inspection by E. P. Cliff, Assistant Chief in Charge of National Forest Administration, and Roland Rotty of the Branch of State and Private Forestry, representing the Chief. The inspectors visited 4

of our 11 experimental forests and ranges and reviewed the work of each division in office and field discussion.

On October 13 Secretary Ezra T. Benson announced plans for reorganizing the Department of Agriculture. This action had a notable effect on the work and organization of the station. Responsibility for forest insect and disease research was given the Forest Service. In the Pacific Northwest, programs, personnel, and facilities of the Portland Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, and of the Portland Office of the Division of Forest Pathology, Bureau of Plant Industry, Soils and Agricultural Engineering are transferred to the station where they will be respectively the Division of Forest Insect Research and the Division of Forest Disease Research. The first-named division is headed by R. L. Furniss and consists of 8 technical personnel and the second is headed by J. L. Bedwell and consists of 5 technical personnel. Although the transfer did not become effective until January 3, 1954, it was considered appropriate to record 1953 activities and accomplishments including publications and plans for 1954 in these two fields of work in this report. To avoid confusion these divisions will be referred to under their new titles regardless of their actual status at time activities being reported were conducted.

This region, particularly the Douglas-fir subregion, is supporting two distinct forest economies--one operating on old-growth timber and one on second growth. Each have separate problems although they have many in common. Research and its application on second-growth management influences old-growth management and vice versa. These counterforces combined with external physical and economic phenomena create complex problems. A striking example is the effect of insect epidemic attacks. At times control by salvage is the only practical means. To accomplish salvage programs means alteration of management plans. Control of normal insect and disease losses through management is necessary and yet it may have to be interrupted to salvage epidemic losses. These conditions emphasize need for expanded and coordinated research in the protection phases of forest management; insects, disease, and fire. The Northwest Forest Pest Action Committee analyzed and reported on forest insect and forest disease research in 1953 showing specific needs for an accelerated program. Close coordination has always existed between research men and agencies in forest insects, forest disease, fire control, and other phases of forest management research. Having them all in one office will mean greater opportunities for strong coordinated attack on the major problem of finding technical measures for optimum management of the Pacific Northwest forests.

The departmental reorganization also resulted in transfer of the station's work in range reseeding to the Agricultural Research Service, which will necessitate reorientation of the range research program.

Active work was under way during the year at 10 of the station's 11 experimental forests and ranges. The name of the Blue River Experimental Forest was changed to the H. J. Andrews Experimental Forest and on July 26 it was dedicated in memory of Regional Forester Andrews.

The scope of the station's activities is too extensive to permit singling out or summarizing accomplishments briefly. The following pages will provide the reader with summaries and detail division by division.

FOREST MANAGEMENT RESEARCH

Several developments influenced the scope and direction of the station's program in forest management research.

All field studies in western Washington, including those at the Wind River Experimental Forest, were placed under the supervision of the Puget Sound Research Center early in the year. This move helps to coordinate forest management research in western Washington and brings most of the studies in young-growth Douglas-fir under the direction of one unit. A necessary economy measure was the reduction in the technical crew at the Wind River Experimental Forest from two men to one.

At the Siskiyou-Cascade Center an advisory committee with members from Federal and State forestry agencies and from forest industry was organized during the fall, and the first meeting was held in December. Committees for the Puget Sound and Deschutes centers, now in their second year, are continuing to help guide forest research in those areas.

Past research efforts at the South Umpqua and Port Orford Cedar Experimental Forests have been hindered by a lack of access roads. At the South Umpqua this situation has been alleviated by the completion, during 1953, of a permanent bridge across the South Umpqua River. A sale of some 14 million board feet late in the year also provides for the construction of 7.7 miles of main road and a mile of spur road. These will be operator built during 1954 and will open up a large part of the experimental forest. A similar sale of 13 million feet on the Port Orford Cedar Experimental Forest will provide about 4-1/2 miles of access road.

Both the name and program were changed at the H. J. Andrews Experimental Forest in the central Oregon Cascades. Formerly known as the Blue River Experimental Forest, the name was changed to honor the former regional forester for the Pacific Northwest Region. Dedication of a memorial plaque at the entrance to the forest took place in July. The Willamette National Forest is assuming a major share of the responsibility for the development and timber sale program on the forest, thus enabling the station to start a number of long delayed studies on regeneration, windfall, and mortality.

New appraisals of the forest problems in the Deschutes and Siskiyou-Cascade research provinces were completed during the year. Following critical review by the advisory committees and the station staff, these will be put in final form and will serve as a program guide in the selection of new research projects and the establishment of study priorities.

A major undertaking at the Deschutes center was the development of plans for an experimental management unit in cooperation with national forest administration. Located adjacent to the Pringle Falls Experimental Forest, the unit will be used for pilot plant tests of management practices for ponderosa pine and lodgepole pine. A working

agreement has been drafted, tentative boundaries established, and guidelines for the initial development period worked out. Emphasis will be given to: all-aged versus even-aged silviculture, insect and disease control, inventory systems and requirements, determination of allowable cut, age-class control, and the costs and returns from intensive management.

At the Cascade Head Experimental Forest, the cooperative agreement with Publishers' Paper Company was modified to permit road construction well in advance of actual logging and during favorable weather. The research program at Cascade Head was strengthened through a new time and cost study of high-lead logging. The study is in cooperation with Magnus Tennas, a Norwegian research forester, who is in the United States on a Smith-Mundt scholarship.

Several members of the division assisted in the development of criteria for rating the productivity of recently cut lands in the Pacific Northwest. The resultant guides will be used in Task VIII of the nation-wide Timber Resource Review.

Noteworthy findings and progress during 1953 in various phases of forest management research are summarized in the paragraphs that follow.

Planting

Some of the early planting experiments are just reaching the period of greatest value. At Wind River, a spacing study of Douglas-fir provides a striking comparison of the development in plantations when spacing between trees is varied from 4 to 12 feet. The latest examination 27 years after planting shows that wider spacings have accelerated diameter growth and produced a much larger volume of usable wood. The wider spacings also produced a taller dominant and codominant stand. Limb size increased under wider spacings but averaged less than three-fourths inch in diameter even for the 12-foot spacing. Pruning will apparently be necessary in all spacings to produce clear wood within a rotation of 100 years. Where the objective is to grow a maximum volume of sawtimber in the shortest possible time, spacings as wide as 10 and 12 feet show definite advantages. Since planting cost per tree is nearly the same for all spacings, a material saving in planting costs per acre is possible.

The large yields obtainable at an early age from Douglas-fir plantings are revealed by records from a 19-year-old plantation near Quinault in the Olympic National Forest. Site quality is II, and trees were initially spaced 8 by 8 feet. Trees are now 45 feet tall, and dominants average 7.3 inches d.b.h. Total stem volume totals 3,197 cubic feet per acre--more than twice the normal for fully stocked natural stands of the same age and site. Total basal area is 160 square feet. Partial volume (trees over 6 inches d.b.h. to a 4-inch top) amounts to 2,190 cubic feet, or 27 cords per acre. Total basal area is 160 square feet. Since the stand is just entering the period of most rapid growth, annual increment for the next 30 to 40 years should easily double the average of the first 19. Pruning and thinning plots were installed during 1953 to determine if these measures will effectively boost volume or quality production.

Does stored planting stock survive and grow as well as freshly dug stock? The answer is "yes" according to a study recently completed in the Oregon Coast Range. Some 2,400 seedlings of Douglas-fir and Port-Orford-cedar were planted on a clear-cut tract in 1943. Half were freshly dug seedlings and half had been stored in a cold room at the nursery for two months prior to planting. Survival and height growth of the stored stock were even slightly better although statistical tests indicated the differences were not significant at the end of the tenth growing season.

Douglas-fir 1-0 stock survived better than 2-0 stock when planted under heavy bracken cover in a trial on the Hemlock Experimental Forest near Grays Harbor, Washington. The stock was furnished by the Industrial Forestry Association from its tree nursery at Nisqually, Washington. At the end of three growing seasons, survival of the 1-0 stock was 77 percent compared to 60 percent for standard 2-0 stock and 54 percent for extra large 2-0 stock. Differences in height growth among the three classes of stock were very slight.

Seeding

In terms of germination and survival Douglas-fir was found to be the best species for direct seeding on the Forks burn of northwest Washington in a study begun in 1952. After two growing seasons, survival and stocking (based on minimum of one seedling per mil-acre plot) were as follows:

Species	Survival	Plots Stocked
	Percent	
Douglas-fir	36	21
Western hemlock	30	27
Sitka spruce	11	9
Port-Orford-cedar	20	3

When the number of seeds sown and their viability are both taken into account, Douglas-fir produced about 2-1/2 times as many seedlings as the average for all species. Sitka spruce and Port-Orford-cedar produced less than one-half the all-species average.

Use of preloaded Keyes screens for direct seeding sugar pine and ponderosa pine has been tested for several years in southwest Oregon. The Keyes screen serves a dual purpose: it protects the seed and newly germinated seedling from rodent damage, and it permits surrounding the seed with a favorable medium for germination and initial growth. One study phase was begun in August 1952 to determine for sugar pine the best time of year to plant the screen and to compare screens loaded with soil and vermiculite. Screens were planted in August and again in September, October, November 1952, and April, May, and June 1953. Half of the screens were loaded with soil and half with vermiculite. In both cases the material was pretreated with Semesan and fertilizer. Unstratified seed was used in the late summer and fall trials, while

stratified was used in all the spring trials. Germination and initial survival were as follows:

Month planted	No. of seeds germinating 1/	Seedlings alive September 1953
August 1952	166	100
September 1952	160	124
October 1952	166	96
November 1952	168	107
April 1953	163	90
May 1953	164	88
June 1953	29	13

1/ 180 seeds were planted each month.

Although June sowing of stratified seed gave poor results, differences among the other months are very slight. Apparently sugar pine can be successfully seeded at any time from August through May. Late summer has a number of practical advantages because labor is more abundant and working conditions better. Germination is also more rapid for the early fall sowings. This could easily result in higher seedling survival in a dry year. The medium used in loading the screens had only a slight influence on the number of seed germinating. However, germination was completed more rapidly in vermiculite than in soil, and survival was likewise superior. In September, 69 percent of the seedlings in vermiculite survived, compared to only 53 percent in soil.

Field tests of tetramine treated seed were continued in cooperation with the Denver research laboratory of the Fish and Wildlife Service and the Supervisor of Forestry for the State of Washington. Results with both Douglas-fir and ponderosa pine show that this combination repellent and rodenticide holds promise for effectively protecting the seed from rodent damage without seriously reducing its viability.

In a 1953 trial at Mayfield, Washington, an area sown with tetramine-treated Douglas-fir seed at a rate of one pound per acre produced 10,397 seedlings per acre at the end of the first growing season. Untreated seed on a comparable check area produced only 793 seedlings to the acre. Where both treated and untreated seed were planted in rodent exclosures on the same area, tetramine was found to reduce both germination and survival by only 5 percent.

On the Brink sale area of the Umpqua National Forest, ponderosa pine seed treated with tetramine showed a reduction in germination of 9 percent as compared with untreated seed. This was a greater loss in viability than experienced in other tests with ponderosa pine at the Siskiyou-Cascade center. The treatment provided good protection against rodents, however. Two weeks after the October seeding, only 2 percent of the seed spots in the treated area had been disturbed by rodents compared to 40 percent in a nearby area sown with untreated seed.

In both the trials with Douglas-fir and ponderosa pine, tetramine did not eliminate the rodent population but protected the seed effectively through its combined repellent and poison properties.

In the fall of 1953, the station assisted with two large-scale seed spotting tests of 50 and 80 acres on the Umpqua and Rogue River National Forests. Sugar pine and ponderosa pine seed coated with tetramine and dextrin were used in these trials.

Forest Tree Improvement

The need for a full-scale program of genetics research for Northwest species was recognized at meetings held during July at both Portland and Seattle. Accomplishments and needs were discussed with representatives from industry, colleges, Federal and State agencies, and private individuals. A tentative plan for genetics research in the Pacific Northwest is now in preparation to serve as a basis for further group meetings early in 1954. Isaac's recent trip to Europe will help to provide firsthand information on the methods of study and progress in European countries.

The station also worked closely with the Division of Timber Management in the preparation of a plan for selection and improvement of seed collection areas and seed orchards on the national forests.

Past work by the station in tree improvement has been conducted chiefly as a sideline to other fields of endeavor. Main efforts include the tests of strains of Douglas-fir and ponderosa pine, and field trials of stock developed at genetic institutions in other parts of the country.

Recent examination of the 39-year-old Douglas-fir heredity plantation at Wind River revealed apparent differences in limb development and resistance to ice breakage. The Granite Falls, one of the fastest growing strains, has proved highly susceptible to ice breakage. Differences in limb size among the various strains are also pronounced; the local Carson strain has produced the largest limbs.

Field trials of the ponderosa-scopulorum hybrid, developed at the Institute of Forest Genetics at Placerville, California, were started at the Pringle Falls Experimental Forest in the spring. Stock from the ponderosa parent (Eldorado), from Jeffrey pine, and from local ponderosa pine was interplanted with the hybrid. First-year observations show that local rodents prefer the hybrid stock to seedlings from the other sources. Their second preference was the ponderosa (Eldorado) parent. Remaining hybrids and parent stock have been protected by screens to prevent further damage. Small groups from the same stock have been planted in the Wind River Arboretum.

Management of Old-growth Douglas-fir

Research on harvest cuttings and natural regeneration in old-growth Douglas-fir is mostly concentrated on the H. J. Andrews Experimental Forest. Here, research and national forest administration are pooling their efforts in the gradual conversion of a 15,000-acre watershed of virgin forest to a managed forest.

Better design of staggered settings has been a continuing objective. In early sales boundaries of clear-cut units were based largely on the economic yarding distance of a centrally located landing. This practice minimized yarding costs, but often aggravated slash burning and windfall salvage problems. In sale 3, logged during 1953, roads were laid out in distinct levels, and cutting units included entire blocks of timber between road levels. Roads at the top and bottom of the unit form the upper and lower cutting boundaries. Side boundaries are fairly straight and at right angles to the contours. In this scheme, roads are used for the most critical fire lines and are located to facilitate maximum salvage of windfall. Three units slash burned during the fall illustrate some of the inherent advantages. Critical fire lines were patrolled by automobile, and fires that jumped the upper boundary were quickly extinguished by pumper trucks that could be driven to within a few feet of the fire. Men doing the burning were also able to work downhill from the upper road and could be picked up at the bottom when burning was completed.

How much road in staggered setting cuttings? Road requirements for an intensively managed old-growth watershed and their impact on forest productivity have been estimated from experience on the H. J. Andrews. Complete layout for 8,800 acres shows that about 5.19 miles of road are required per square mile of forest land. When allowances are made for forest encroachment on the roadbed and probable loss in productivity on cuts and fills, a permanent road system is estimated to remove about 2.9 percent of the forest land from production. Measurements of disturbance during landing construction indicate a further loss of about 1.2 percent from this source.

Windfall around staggered setting cuttings is being studied in detail on the H. J. Andrews. Almost 8 miles of cutting boundary have been sampled to furnish information on wind funnels, the movement of wind from one clear-cut unit to the next, and the relative windfall on various kinds of cutting boundaries.

Records of logging costs on experimental sales provided two significant comparisons during 1953. In one, costs of high-lead and tractor yarding were compared on two adjacent areas with gentle topography and maximum yarding distances of 600 to 800 feet.

Final costs were as follows:

Item	Tractor	High-lead
Basis	856 M	1,587 M
Yarding labor	$2.20	$2.41
Supplies and repairs	2.14	1.18
Total yarding	$4.34	$3.59
Loading labor	.92	.64
Supplies and repairs	.56	.18
Total loading	$1.48	$ .82

There is apparently no distinct advantage for tractor logging when the ground conditions are equally favorable for either method. Two trials of downhill high-lead yarding at maximum distances of 900 to 1,000 feet on steep ground showed that logging costs are consistently increased about $1.00 per thousand board feet in comparison with uphill yarding on similar ground.

Does restocking on clear-cut units follow a definite pattern? A study of 5 units, logged two to three years ago on the H. J. Andrews, provides some provisional answers. The best regeneration occurred in the stand shadow along the south border of the units. About one-third more seedlings were found in skidroads than in undisturbed ground between them, and seedlings were more numerous on unburned than burned seedbeds. Stocking was uniformly low where the ground was covered by medium to heavy accumulations of unburned slash. Of special significance was the finding that 90 percent of the surviving seedlings had their stems shaded at ground level during the heat of the day. Only 50 percent of the surviving seedlings were completely in the shade.

Exploratory studies of high surface soil temperatures at the H. J. Andrews are helping to provide a better understanding of the role of shade and heat in the restocking of staggered setting cuttings. Previous work had demonstrated that newly germinated seedlings of Douglas-fir can be killed by heat when the surface temperature reaches 125° F. The majority of seedlings are probably lost when the surface soil temperature is in the range of 130° to 140°. Lethal temperatures were found to occur frequently on a south slope and valley bottom throughout the 1953 growing season. In contrast, lethal temperatures were not recorded on the adjacent north slope until early July and were of relatively short duration. Under valley bottom conditions at an elevation of 1,800 feet, litter and charred soil reached the critical temperature for seedlings when the air temperature was about 80°. The corresponding figure for mineral soil was about 95°.

Wax pellets which melt at 138° were used to determine the percentage of a clear-cut unit subject to lethal soil temperatures. A freshly logged and burned unit of 36 acres on a gentle-to-steep north slope was sampled at 80 points during late June and early July. These samples showed first, that only 35 percent of the unit had actually been burned over in the slash fire. Roadbeds, rocks, and streams which are not available for restocking were found to cover 13 percent of the area. Sixty percent of the area was available for restocking but subject to surface temperatures of 138° or above during this period. Only 27 percent of the cutting area was found to be both available for restocking and protected from lethal temperatures. On a valley bottom or south slope, the proportion would be even smaller. These exploratory studies indicate high surface temperatures may be a major deterrent to early establishment of Douglas-fir seedlings on clear cuttings in the Oregon Cascades.

Satisfactory reproduction of Douglas-fir and western hemlock was obtained within 5 years on 6 small group cuttings in old-growth Douglas-fir on the Olympic National Forest. The groups ranged from 1.2 to 4.0 acres in size. On an adjoining 300-acre clear-cut tract, satisfactory restocking was confined to a strip within 500 feet of the uncut timber edge. Douglas-fir reproduction was also more numerous and vigorous on the small cuttings than on the large clear-cut area.

Management of Young-growth Douglas-fir

Research continues to demonstrate that young-growth Douglas-fir offers outstanding opportunities for profitable management. Potential growth and yield are strikingly demonstrated by a 26-year record of growth plots covering 4-3/4 acres of site II land on the Gifford Pinchot National Forest. The stand has grown an average of 1,900 board feet per acre yearly between the ages of 52 and 78 years. Volume now totals 86 M board feet per acre. Mean annual increment has not yet reached a maximum, and, since value is increasing even faster than volume, the record indicates that the most profitable rotation is considerably longer than 78 years, the present age of the stand. Mortality has claimed an average of 190 board feet per acre annually in trees of merchantable size. If these trees could be utilized in light frequent thinnings, the already spectacular net growth could be increased by more than 10 percent.

Increased interest is being shown in precommercial thinning of young Douglas-fir as a practical forest improvement measure. Several older studies now provide evidence of possible gains, and two new studies were begun during 1953.

That larger and taller trees result from early thinning is demonstrated by a study in a dense site IV stand on the Wind River Experimental Forest. Stands were thinned to a spacing of about 8 by 8 feet when they were only 9 years old. At age 42, trees in the thinned stands average 7.8 inches in diameter and 68 feet in total height compared to 5.1 inches and 54 feet in the unthinned stand. Total cubic volume averaged slightly more on the thinned plots and board-foot volume by International rule

was more than twice as great: 25,000 board feet as against 11,000. This is believed to be the first evidence of the beneficial effect of early thinning on volume production in young Douglas-fir.

In another thinning study at Wind River, a 30-year Douglas-fir stand was thinned from below to the extent of 22 and 30 percent of the basal area. The heavier cut reduced periodic growth immediately after thinning, while the lighter treatment increased growth slightly. Ten years after thinning, both areas showed a higher periodic increment than the unthinned stand. Here, again, thinning has also produced a stand of larger and taller trees.

The influence of spot thinning on individual trees in a 40-year-old stand of Douglas-fir is the subject of a new study begun at Wind River this year. Four degrees of release were applied to selected dominants, codominants, and intermediates. This information is needed to provide a basis for drafting improved marking guides for thinning young-growth Douglas-fir.

Management of Sitka Spruce and Western Hemlock

Of special interest at the Cascade Head Experimental Forest in 1953 was a commercial scale test of thinning on steep slopes. The trial was made in a fast-growing stand of 100-year-old Sitka spruce and western hemlock that was losing upward of 500 board feet per acre annually in mortality. Logging was done with a portable yarder-loader with 300 feet of 1/2-inch main line. The machine was a 4/10-yard shovel mounted on a half-track and equipped with a heel boom. The yarder-loader was located at frequent intervals along a truck road, and logs were yarded up to the road through natural corridors in the stand. Thinning covered a strip of timber 200 to 300 feet wide on the steep slopes below the road. Low quality and crowded trees were removed and merchantable snags were salvaged. Of an original stand of 76,380 board feet per acre, thinning took out about 13 percent.

Total logging and hauling costs were about equal to costs of high-lead clearcuttings in the same stand. Of the residual trees, 15.4 percent sustained some type of injury. This compares favorably with an average of 23 percent for conventional thinnings on gentle ground using horse or tractor. The success of the trial holds promise that a sizable portion of the mortality now being lost in well-stocked stands on steep ground can be utilized. The yarder-loader is also well adapted to salvage of scattered blowdown, picking up right-of-way logs, and cleaning up small chunks left at high-lead landings. As a shovel, it can also be used for loading rock and cleaning ditches and culvert basins.

An exploratory test of chemical debarking of Sitka spruce, western hemlock, and red alder was started at Cascade Head in July 1952. Some 88 trees were girdled and painted with sodium arsenite, monochloroacetic acid, polybor, and a polybor-chlorate. None of the treatments provided adequate bark removal after one year, and all logs still

had to be barked at the pulp mill. There was likewise no measurable difference in the weight of logs from treated and untreated trees. Sodium arsenite was the most promising chemical. In this treatment the bark was free from the sapwood but still formed a complete cylinder around the bole even after felling, bucking, yarding, and loading.

Ponderosa Pine Management

A major contribution of the Deschutes Research Center was the publication in June of a research paper "Thinning Ponderosa Pine in the Pacific Northwest." This brings under one cover the main findings from a series of 25 thinning plots located in many parts of eastern Washington and eastern Oregon. Some of the thinning trials were started as early as 1927. Another station paper of more than usual interest to ponderosa pine foresters and researchers was "Soil Moisture and the Distribution of Lodgepole and Ponderosa Pine." Though based largely on a review of the literature, the paper helps to clear up a number of common misconceptions on the major factors affecting distribution of the two species.

One new thinning study was established at Pringle Falls to determine if distinct dominants in young even-aged ponderosa pine stands respond to release when stems in the subordinate crown classes are removed.

A study of lumber grade recovery from young even-aged ponderosa pine was completed during the year. Trees removed from a 105-year-old stand growing on a low site III consistently produced a good grade of common lumber but no material in the select grades. Close grown trees yielded 18 percent more volume per acre, 13 percent more No. 2 common lumber, and 8 percent less No. 4 and No. 5 common lumber than open grown trees of the same age. The open grown trees were 5 inches larger in diameter, however, and contained over twice the board-foot volume per tree. Economic advantages of dense or open stands are difficult to assess because the increased volume and quality from the dense stand is in part offset by the increased cost of logging and milling the smaller trees. Of special interest was the disclosure that ponderosa pine can be expected to produce only a negligible volume of clear lumber under practical rotations unless the lower limbs are artificially pruned at an early age.

Management of Mixed Conifers of Southwest Oregon

Although mixed stands containing sugar pine and ponderosa pine are receiving top priority in the research program at the Siskiyou-Cascade center, some attention is also given to the Shasta red fir type of the high Cascades and to the stands containing Port-Orford-cedar along the Oregon Coast.

Pruning of potential sugar pine crop trees to save them from blister rust was completed on a 35-acre tract of the South Umpqua Experimental Forest. In this pilot plant operation, infected branches were removed from savable trees. All branches in the lower third of the live crown were pruned up to a maximum height of 18 feet. Crop trees were marked by station

personnel and pruned by a contractor. Contract prices were 15 cents for trees 1 to 4 inches d.b.h., 25 cents for trees 5 to 8 inches, $1.00 for trees 9 to 12 inches, and $1.50 for 13- to 16-inch trees. Altogether, 4,000 promising sugar pines in reproduction patches now 40 years old were treated. The study area is within a sugar pine management unit where ribes eradication was carried out in 1948. Pruned trees will be examined periodically to check both the effectiveness of canker removal and ribes eradication. Where sugar pine is to be grown commercially, both measures may become an integral part of intensive management.

The theory that natural reproduction of sugar and ponderosa pines can be favored by removing all other species is under study in two mixed-conifer stands of the Umpqua National Forest, cut in 1952-53. Seed traps were installed this year to measure the seedfall resulting from a moderately good 1953 crop. Restocking will be charted on semipermanent quadrats. One of the cutting units was also treated with 1080 bait to test the possible use of rodent poisoning for protecting natural seedfall. Acceptance spots baited with sugar pine seed will provide a continuing check of rodent activity.

Reproduction problems in the South Umpqua drainage will be pinpointed through a survey begun last summer of 60 sample cutovers. In addition to appraising the size of the regeneration problem and location of critical areas, the survey is designed to furnish some clues on possible causes of poor restocking and probable composition of future stands. Sixteen of the sample cutovers were examined in 1953 and the remainder will be covered during 1954.

Growth and yield of Port-Orford-cedar in pure stands and in mixture with Douglas-fir received attention for the first time in 1953. Pure stands are rare in nature and growth data will be obtained from a few sample stands. Growth information for cedar in mixture with Douglas-fir, the usual stand condition, will be based on studies of individual trees. Field work for the pure stands was completed during the field season.

Survival of Shasta red fir seedlings that germinated on a clear-cut of the Rogue River National Forest in 1952 was observed through the second growing season. Second-year mortality was light with numbers of seedlings per acre falling from 2,189 to only 1,708 between the fall of 1952 and the fall of 1953. During the same period, seedlings of other species were reduced from 75 to 56, and advanced growth from 292 to 252 per acre. As measured on milacre quadrats, the area is still 44 percent stocked with seedlings of Shasta red fir. Light mortality is attributed to an exceptionally wet growing season during 1953.

Brush Control

Throughout the Pacific Northwest, the problem of getting tree reproduction established on sites occupied by woody shrubs and brush is receiving increased attention. The problem is complex because the aggressive shrub species vary by forest type and locality. Alder, vine

maple, and salal create a problem in many parts of the Douglas-fir region. Salmonberry and associated species prevent regeneration in the coastal forests of spruce and hemlock. Various species of manzanita and ceanothus warrant attention in the ponderosa pine region and in the mixed pine types of southwest Oregon.

Prescribed burning of slash is under trial at Cascade Head and at Henderson Creek to retard salmonberry and give planted trees a head start. In 1952, the work was expanded to include tests of chemical control. So far, 1-to-1 mixtures of 2,4-D and 2,4,5-T, or 2,4,5-T alone have proved the most promising for salmonberry. When foliage was completely wetted with a spray of either preparation, a defoliation of about 90 percent was obtained. A few scattered sprouts appeared from the root crown the first season, and sprouting was even more vigorous the second season. Concentration was 4,375 parts per million with water for a carrier. The propylene glycol butyl esters seemed equally as effective as the butoxy ethanol esters. Other chemicals tested were less effective against salmonberry, too expensive, or severely damaged the coniferous seedlings. Heavier concentrations of 2,4-D and 2,4,5-T were likewise found to severely damage the conifers.

The susceptibility of important brush species to chemicals is also being tested at the Deschutes and Siskiyou-Cascade centers. Preliminary observations at Pringle Falls show that 2,4-D and 2,4,5-T are both effective in killing nonsprouting manzanita. Both herbicides are also effective in killing aerial portions of snowbrush, but not the roots. Young ponderosa pines that were protected under the brush were only slightly damaged by the spray, while those receiving the direct spray were severely damaged or killed. Oil carriers damaged young pines more severely than water carriers.

Forest Measurement

"Volume Tables for Permanent Sample Plots" processed by the station during 1953 brings together under one cover the best existing total height volume tables for the Douglas-fir region. The compilation is a product of the Committee on Standardization of Growth Computations--a subcommittee of the Puget Sound Research Center Advisory Committee.

During the year, 126 volume tables from the mensuration files were also assembled and classified. They cover 17 Northwest species and a wide variety of specifications. Some of the tables have been widely used, and others are relatively unknown and unavailable to practicing foresters. The compilation has been proposed for publication as a Department of Agriculture Handbook. A unique feature will be a heading for each table which lists the standards and specifications completely and uniformly. This will facilitate comparing standards in selecting volume tables for specific purposes.

Assistance was extended to the region's Division of Timber Management on several projects involving sampling or survey techniques. One was an attempt to reduce the administrative burden of scaling small logs by weighing all truck loads of logs and scaling a sample of truck loads.

The ratio of total scale to total weight is first obtained for all sample loads. This ratio is then applied to the total weight of all loads to provide an estimate of total scale. A trial analysis showed that if 20 loads are both weighed and scaled, the sampling error of the estimated scale of all loads in any month will be 5.6 percent.

A plan was also developed for a survey to determine if staggered settings are restocking naturally, and how much timber along the edges of staggered settings is lost through windthrow. This information is urgently needed to provide a factual basis for evaluating the staggered setting system of cutting as applied on the national forests of the Douglas-fir region.

Assistance was also given the region in the development of improved methods for obtaining the basic forest inventory data needed in the preparation of management plans for national forest working circles. One method now under test in the Douglas-fir region promises to cost less than methods previously used, with no sacrifice of essential information. An adaptation of the new method was also recommended for use in the forest resource survey in Alaska.

The new yield tables for western hemlock were submitted to the Washington office in November. Following board of review, the manuscript will be revised as necessary and readied for publication as a Technical Bulletin in the Department series.

Forest Soils

The findings of a soil-site study for Douglas-fir were presented at the 1953 meeting of the Soil Science Society of America by W. A. Carmean, now with the Central States Forest Experiment Station. Field work during 1949-50 was carried out in southwest Washington to determine the relation of Douglas-fir site to soil, climate, and topography. Significant findings were:

(1) Site quality decreases with an increase in elevation and with an increase in gravel content and compaction of soil layers above the substratum.

(2) Site quality increases with an increase in total annual precipitation and with an increase in depth to the substratum.

(3) Site quality also improves with an increase in the product of moisture equivalent and gravel content of soil layers above the substratum. This indicates that adverse effect of gravel is less pronounced in fine-textured soils.

Equations expressing these relationships have been prepared for the five major soil groups that occur in southwestern Washington. From these, site index tables for estimating growth capacity of deforested or recently restocked forest lands can be calculated.

Other soil studies receiving attention during 1953 are reported in the section "Slash Burning in the Douglas-fir Region."

Fire Studies

Following two successive fire seasons of record-breaking severity, 1953 set new records for low fire danger in western Oregon and western Washington. Seasonal ratings are determined by analyzing daily observations from several key Weather Bureau stations. The ratings are based on total number of rainless days, average number of days since a wetting rain of one-fourth inch or more, and burning index. The low danger in 1953 is attributed to a cool, wet spring, above normal relative humidities during the summer, general rains in late August, and recurring fall rains. October was more favorable for slash burning than any fall period in recent years. The low fire danger is reflected in the lowest acreage burned since fire records have been kept for Oregon and Washington.

A critical look at methods used in the appraisal of cloud seeding was made as one phase of fire-weather investigations. The analysis suggested a new approach based on the comparison of rainfall from a seeded storm with the normal for that particular storm type. The method is believed to merit trial and a technical article will be submitted for publication early in 1954.

Progress on some other phases of fire research is given in the section that follows.

Slash Burning in the Douglas-fir Region

Records on the behavior of slash fires in relation to fuels, topography, and weather conditions have been collected intermittently for several years. Some 63 case studies on five national forests show that fuel moisture indicator sticks can be used to help determine a desirable time for burning slash. Fires in well arranged fine slash were found to spread satisfactorily without excessive lighting, when sticks exposed to the sun in the slash area show a moisture content of 13 to 14 percent or lower. When the moisture content in the slash area is higher, fine slash usually will not carry a fire satisfactorily. A second indicator stick placed in the shade of bordering green timber should at the same time show a moisture content of 18 percent or more to minimize the danger of the slash fire escaping into the green timber.

A major study was started in 1948 to determine the influence of slash fires on fire hazard, regeneration, brush development, and soil structure and properties. Several leads on the possible effects of slash fires on soil properties and initial germination and survival of Douglas-fir seedlings were obtained in 1953. A laboratory study of the influence of high temperatures on soil color and reaction (pH) showed a temperature of about 900° F. is required to alter the color of mineral soil to a point of no further change. Tests of temperatures ranging from 600° to 1,500° also demonstrated that color after burning is not a reliable measure

of the severity of the fire. Differences in amount and type of clay minerals strongly affect color changes. The greatest change in pH occurred at temperatures below 900°. At higher temperatures, length of exposure made little or no difference.

Information on change in soil reaction and trend of pH following slash burning was provided through analysis of soil samples collected on three major soil types that had been subjected to slash fires. The following relationships held true on all three soil types:

(1) Change in pH increases as burning becomes more severe.

(2) The first year after burning, pH begins to return toward normal and reaches the highly acid condition characteristic of Douglas-fir soils at the end of four years.

(3) Unburned soils within a clear-cut area are not significantly different in pH from undisturbed soils in adjacent timber.

Both studies suggest that changes in soil reaction would likely be minimized if the slash fire moves rapidly through light fuel when duff and surface soil are moist. Under these conditions, less heat is developed and duration of maximum temperatures is reduced.

A cooperative study with the University of Washington was started in 1953 to explore the effects of slash burning on the chemical properties of the soil and on seed germination and seedling growth. Preliminary results indicate that burning increases the available phosphorus and potassium.

That highly alkaline soil conditions do not inhibit the germination of Douglas-fir seed was demonstrated in another laboratory trial where seeds were placed in media varying from pure sand with a pH of 6.0 to pure wood ash with a pH of 9.5. No significant differences in germination rates occurred within this range of soil reactions. In the ash mixtures, however, all seedlings died from damping-off within a few days after germination. High pH is known to favor development of damping-off, but whether or not a high pH can be responsible for high damping-off losses to natural seedlings under field conditions is still in the realm of conjecture. This phase will be given attention in 1954.

A study of the effect of slash burning on occurrence of mycorrhizae on roots of Douglas-fir seedlings is reported in the section on "Forest Disease Research."

Plans for Forest Management Research in 1954

No major program changes are anticipated during 1954, and overall division efforts will be focused on the three following objectives:

1. To strengthen going projects through active advisory committee guidance; through further cooperative studies with the States, colleges, other Federal agencies, and private companies; and through continuing and critical review of the current program and organization.

2. To develop a plan for tree improvement research that is geared to the forest management needs in the Pacific Northwest and to explore means for activating a full-scale program in forest genetics through cooperative effort.

3. To make available to practicing foresters the sizable backlog of information that has been collected but not yet fully analyzed or published.

Three Departmental publications, now in varying stages of preparation, review, or revision, will be carried as rapidly as possible to completion. These are (1) "Yield of Even-aged Stands of Western Hemlock" (for Technical Bulletin); (2) "Volume Tables for Pacific Northwest Trees--A Compilation" (for Agriculture Handbook); and (3) "Decay Following Logging Injury to Western Hemlock, Sitka Spruce, and True Firs" (for Circular, in cooperation with Division of Forest Disease Research. The possibilities of a circular on red alder management and utilization will also be explored jointly with the Forest Utilization Service.

In forest soils, effects of slash burning on chemical, physical, and biological properties will be subjected to further intensive study.

Fire studies will give first priority to the completion of progress reports on long-time studies in fire behavior, prescribed burning, and effects of slash burning on fire hazard, regeneration, and brush development.

At the Puget Sound center, annual commercial thinnings will be continued at all five experimental forests. Six years of experience with thinnings at Voight Creek and five years of experience at McCleary will be summarized in progress reports. Field installations for a new spacing-increment study will be completed on the Hemlock and Wind River Experimental Forests. Juvenile stands of Douglas-fir will be thinned to densities varying from 50 to 350 trees per acre. Field trials of tetramine in direct seeding of Douglas-fir will be reported in a technical article. The possibility of a cooperative agreement to facilitate the method-of-cutting studies under way at Wind River will also be explored.

Needed research in brushfield reclamation for southwest Oregon will be the subject of a new project plan at the Siskiyou-Cascade center. Studies of Port-Orford-cedar in plantations and of growth in pure and mixed stands will be analyzed and brought to publication stage. Field work for the survey of natural reproduction in the east portion of the mixed-conifer type will likewise be completed during 1954.

A major task at the Deschutes center is to complete the analysis of results from 32 method-of-cutting plots located in various parts of the

ponderosa pine region and to prepare a summary report on the findings. Considerable effort will also be devoted to crystallizing final plans for the experimental management unit in cooperation with the Deschutes National Forest.

The Deschutes and Siskiyou-Cascade centers are cooperating in a review of the literature and experience on control of problem brush species through chemical or mechanical means. A research paper "Brush Control on Forest Lands of the Pacific Northwest" is planned for 1954.

At Cascade Head, the intensive study of high-lead yarding costs will be completed early in the year. Two publications will receive high priority: (1) A report on seed production and dissemination in spruce-hemlock coastal forests, and a summary of seedling establishment in brush threat areas. The harvest cutting and thinning trials in cooperation with Publishers' Paper Company will be continued on a sizable scale.

Natural regeneration and windfall problems will form the hub of the program in old-growth Douglas-fir management on the H. J. Andrews Experimental Forest. Progress reports on early results of regeneration and windfall studies will be prepared, and an article on improved planning of permanent logging roads will be completed.

FOREST INFLUENCES RESEARCH

Our forest influences research program is still largely in the development stage. In 1953, the most important jobs were:

(1) To determine the nature of the watershed management problems needing research and to develop a plan of investigation.

(2) To maintain the beginnings made in watershed research and cooperate, where possible, in current watershed problems requiring action.

In the first of these tasks, the analysis of needs in research, one can recognize two distinct problems: the resource--water, and the source areas--watersheds. Most people are interested in the first of these--the water--which they use for irrigation, household needs, industrial processing, power generation, and other important needs. Chief concern is to increase the amount available during periods of minimum flow, reduce damage from flooding, and maintain required standards of quality. Some control over these factors is possible by various downstream measures but can never be complete without management in the watersheds whence the supplies are derived. The necessary principles of watershed management have not yet been fully developed, particularly in the Pacific Northwest.

The Well-Moistened Pacific Northwest Has Its Water Problems

People of the Pacific Northwest have long viewed their water resource with complacency; seemingly, nowhere in this country is the supply more abundant and pure. Yet, problems are beginning to appear. They are the result of two general trends, both associated with the rapid development of the area. First, there is an expanding need for water, and, second, we are experiencing increased disturbance of dependable source areas--the high watersheds of the Cascade and Coast Ranges and the Siskiyou, Klamath, Ochoco, and Blue Mountains.

In spite of prolific water supplies in the region, late summer shortages have become increasingly critical. Coincident with this low flow is a period of high overall demand resulting from use for irrigation and domestic purposes. In localized areas, limited water supplies impede further industrial development.

Will Timber Cutting Increase Water Yields?

There is reason to believe that some forms of timber cutting may increase runoff. In the southern Appalachians and central Rocky Mountains, various forms of timber harvesting have upped streamflow or added to the storage of snow water available for flow. Experimental cuttings such as these need trial in the Pacific Northwest to see if we can augment water supplies during late summer. Best hope lies in a cutting method which will allow greater accumulations of the winter snow pack and prolong the period of melting.

Dirty Streams Are Costing Us Money

Muddied streams have been the normal result of watershed disturbance--a problem magnified by the fact that more and more people, industrial plants, and irrigation developments have become dependent upon water supplies. Sediment-filled water means expensive filtering and other treatment for normal use and, in some cases, the supply becomes completely unusable. In addition, there are tangible damages to fishing streams including reduction of food and deterioration of spawning beds.

Lowering of water quality can result from a number of sources. Pollution by domestic and industrial wastes has been the prime offender. Added to this is the ever-increasing discharge of soil and debris into the thousands of streams draining watersheds of the Northwest. Four basic causes appear to be:

(1) Roads (including logging access roads).

(2) Logging (timber harvesting activities including skid trails).

(3) Grazing (domestic livestock and big game).

(4) Fire (including slash fires and prescribed burning).

These major sources of erosion, with the exception of accidental fire, result from land management activities. In some form they must continue if we are to receive full benefit from all our natural resources. The job in watershed management is to gain a better understanding of the factors causing excessive soil movement and to develop practicable counter measures.

Our Problem Areas

A well-rounded program of watershed management investigations would require research in at least five problem areas in Oregon and Washington. These are:

Mid-Columbia (central Washington). Research objectives are to obtain maximum supplies of usable water for irrigation, industry, domestic use, and recreation despite multiple pressures of timber production and grazing by livestock and game; and to learn how to stabilize eroding areas.

Willamette (northwest Oregon). Research objectives are to develop criteria for management of watersheds in old-growth Douglas-fir with particular emphasis on protection of water quality for domestic supply, optimum fish habitat, and maximum life of reservoirs; and to increase late summer flow for supplemental irrigation.

Siskiyou-Cascade (southwest Oregon). Research objectives are to devise modifications necessary to log watersheds with unstable soils; and to determine means for improving the cover on depleted burned-over and brush-covered watersheds.

Blue Mountain-Deschutes (central and northeast Oregon). Research objectives are to determine the effect of grazing by livestock and big game on erosion and water quality and devise methods for improving grazing management.

Watershed Research in the Oregon Cascades

A beginning in watershed research has been made in the Willamette problem area on the H. J. Andrews Experimental Forest. Studies in both forest and watershed management have recently been undertaken in a 15,000-acre area comprising the drainage of Lookout Creek, tributary to Blue and McKenzie Rivers.

In 1948, when research activities were first begun, the entire area was a wilderness of virgin old-growth Douglas-fir. The objective has been to convert the area to a managed forest by following a well-considered forestry-logging plan. The purpose of advance planning is to assure that all objectives in management are considered in achieving an efficient network of roads and an orderly removal of timber.

Conversion from an unmanaged to a managed forest has progressed well. By the end of the 1953 logging season, four timber sales have been

completed on the experimental forest involving removal of about 60 million board feet of timber and construction of approximately 20 miles of road. Timber was removed in patchwise clearings. Boundaries of each cutting group and the most advantageous sites for yarding and loading were designated in advance along with the job of laying out road locations. Thus, it was possible to arrive at the most efficient development of the area and at the same time avoid locations leading to excessive soil disturbance and destruction of normal stream channels.

A wide variety of practical problems has been encountered in the attempt to reduce erosion. However, there has been opportunity to experiment with methods for overcoming them and eventually there will develop some guidelines for minimizing erosion from logging and road construction in the Douglas-fir region.

Experiment Started on Three Small Drainages

On the same experimental forest, a long-range study has been started to determine the effect of timber cutting on water yield. The only practical method of making such a study is by a continuous and accurate measure of the water flowing from a small drainage over a period of several years. Three small watersheds (180, 240, and 260 acres) have been selected for this purpose and reserved from cutting until the characteristics of streamflow and the normal quantities of yield are determined. At the end of this calibration period, the plan is to remove the virgin old-growth fir on two watersheds leaving the third one as a continuing check on runoff from an undisturbed drainage. The watersheds destined for cutting will provide a test of the difference between two harvesting methods. All merchantable timber will be harvested on one drainage and the second will have timber on about 25 percent of its area removed by patch cutting similar to that being done on the rest of the experimental forest. The evaluation of the two systems will also involve measurements of the relative amounts of sedimentation resulting from road construction and logging.

Streamflow has been measured since August 1952. At that time concrete stream gages designed for continuous accurate measurement of flow were installed in each watershed, and uninterrupted records have been obtained for slightly more than a year.

Municipal Watersheds

In the Pacific Northwest, the Forest Service is responsible in total or in part for the watersheds serving over 100 communities, representing more than one-third of the total population for Oregon and Washington. In most cases these watersheds contain large volumes of highly valuable old-growth timber. During past years, it hasn't been necessary to disturb many of these areas because timber has been available elsewhere.

Recent years have brought a changed economy, however, and timber cutting in municipal watersheds is increasing because of the growing need for removing overmature trees and converting the present stagnated stands to managed forests.

A case in point is a 5,000-acre watershed in the Coast Range of Oregon which supplies water for the city of Corvallis. Beetle attack has been rampant and losses of valuable old-growth timber running into millions of board feet are imminent. The Siuslaw National Forest has been faced with a problem of salvage despite uncertainties regarding the effect of timber removal on the quality of the water supply.

The station has been asked to help by drawing on research experience, which in the case of watershed management has been very limited. We have reviewed the sales contract and, from our experience on the H. J. Andrews Experimental Forest, made suggestions for added safeguards against road and skid-trail erosion. Also, we have obtained the cooperation of the city of Corvallis and Oregon State College in studies to evaluate some effects of logging and road construction on soil structure and stream sedimentation.

Pilot Watersheds

Mission Creek near Wenatchee, Washington, has been designated as one of the 50 pilot drainages included in the Department of Agriculture program to test upstream works. It is hoped that one phase of the program will be devoted to an evaluation of flood and sediment reduction measures. The station has cooperated in the development of a preliminary working plan for some studies designed to be carried on in conjunction with the operation program. In spite of the obvious limitations of this type of investigation, it could serve as a forerunner of a long-range research program in the Wenatchee area.

Plans for Forest Influences Research in 1954

In 1954 every effort will be made to expand the station's program of watershed management investigations. To this end the following activities are planned.

1. Inform the public of the value of research in advancing the knowledge and improving the application of watershed management principles.

2. Complete the analysis of watershed problems and develop a complete plan of research.

3. Continue research recently started at H. J. Andrews Experimental Forest.

4. Continue to explore possibilities of cooperative research effort in watershed management with State and college research organizations, college research organizations, private forestry concerns, and municipal water departments.

FOREST INSECT RESEARCH

Forest insect research in the Northwest by the Department of Agriculture began in 1903 when a one-man field station was temporarily established at Hoquiam, Washington. Insect studies and control were carried on intermittently until 1913, when a field station was established at Ashland, Oregon. The Ashland station was staffed from 1913 to 1924. In 1929, a station under the then Bureau of Entomology was opened in Portland, Oregon, where it has been maintained to the present time. Throughout its existence this station has been closely associated with the Pacific Northwest Forest and Range Experiment Station.

During 1953 one of the outstanding developments was the analysis of forest insect research needs in Oregon and Washington by the Northwest Forest Pest Action Committee. The division acted as an advisor. The report lists the specific needs and sponsors an accelerated program by strengthening the present research organizations and enlisting additional organizations to participate in the research program. The report is being widely distributed by the committee.

The principal activities of the division in 1953 were as follows:

Forest Insect Surveys

Two cooperative surveys were conducted in 1953 to detect and evaluate forest insect epidemics in Oregon and Washington.

The regular annual survey was made cooperatively with the Oregon State Board of Forestry, Washington State Division of Forestry, and many individual foresters, both public and private. This survey covered 47,300,000 acres of forest land in Oregon and Washington, leaving unsurveyed only 1,600,000 acres in southwestern Oregon. The findings were reviewed and acted upon by the Northwest Forest Pest Action Committee. A comprehensive report regarding the principal outbreaks has been prepared and distributed. More detailed information is on file.

A special aerial and ground survey of the Douglas-fir region, to record the spread and intensity of the bark-beetle-blowdown problem in 1953, was made cooperatively with the Bureau of Land Management, Oregon State Board of Forestry, Washington State Division of Forestry, and the station's Division of Forest Economics. The ground sampling to measure blowdown was done in the same way as in 1952. Aerial photo sample plots were substituted for sketch mapping to estimate the amount of beetle-killed timber. The data have been only partially analyzed. A special report will be prepared.

The highlights of the survey findings regarding the most destructive insects are included in the following sections. For more detailed information, refer to the survey report or make specific inquiry.

Improvement of Survey Methods

Studies of aerial survey methods in 1953 were concentrated upon photography as a method of evaluating tree mortality caused by the Douglas-fir beetle. The most intensive study was conducted in southwestern Oregon cooperatively with Weyerhaeuser Timber Company. Eight plots, approximately two miles long and two chains wide, were photographed with panchromatic film (G filter) and color film at 1/6000 scale. Both types of photography were independently checked in the field. In the type of timber studied, color photography has marked advantages over panchromatic photography because of the better recognition of crown details and the considerably shorter time required to pinpoint positions on the ground. The photographs will be interpreted and the data statistically analyzed early in 1954.

Twenty-eight of the 30 photo plots that were established in 1950 in Coos and Josephine Counties in Oregon were rephotographed in 1953 to determine whether the accuracy of measuring mortality on photographic plots can be improved through rephotography. The original photographs gave a relatively poor measure of total mortality. Interpretation of the rephotographs is pending.

A portable light table for stereo viewing of color transparencies in the field was developed in cooperation with Weyerhaeuser Timber Company. As a result of experience with the prototype, a lighter, more compact, better illuminated model was designed and construction was started. The improved model will be ready for field trials in 1954.

The strip viewing method of making aerial surveys was tested in a preliminary way for recording mortality in Douglas-fir type. The tests showed that the viewer should be modified before further tests are made.

Work on the manual for making aerial surveys in the Northwest was continued. Plans call for the issuance of this manual prior to the survey season of 1954.

Spruce Budworm Control

Aerial spraying to control the budworm covered 369,000 acres in 1953. This makes a total of 3,152,000 acres sprayed during the 5-year program at a cost of $3,324,000. The entire program, under the sponsorship of the Northwest Forest Pest Action Committee, has been a cooperative undertaking by timber owners, the States of Oregon and Washington, and the Federal Government. The major accomplishments are:

(1) The epidemic has been steadily reduced from 2,276,000 acres in 1949 to 1,136,000 acres in 1953.

(2) Killing of timber by the budworm has been largely prevented.

(3) Epidemic infestations have been eliminated from western Oregon and the eastern slopes of the Cascade Range in Oregon.

(4) Aerial spraying for budworm control has been proven practical and has since been applied in other parts of the United States and Canada.

The following table summarizes the budworm control work that has been done:

Year	Acres treated	Cost per acre	Total cost	Average kill of budworm
1949	267,000	$1.20	$ 320,400	97
1950	933,000	1.06	988,980	99
1951	927,000	1.06	982,620	98
1952	656,000	1.04	682,240	98
1953	369,000	.95	350,050	99
Total	3,152,000	$1.06	$3,324,290	

Epidemic infestationsby the budworm were reduced from 1,579,000 acres in 1952 to 1,136,000 acres in 1953. After a careful review of the survey findings, the Northwest Forest Pest Action Committee recommended that 162,000 acres be sprayed in 1954 to prevent extensive tree killing and to protect previously sprayed areas. The proposed control units are the La Grande of 62,000 acres and the Malheur of 100,000 acres.

Spruce Budworm Studies

Studies of spruce budworm populations on sprayed areas were continued in 1953. Eighteen sample plots on areas sprayed in 1949 and 1950 were re-examined periodically during the season, and numerous general observations were made on other sprayed areas. Only one control unit had any appreciable reinfestation; all others harbored only light populations of the budworm. It is evident that, under the conditions in Oregon and Washington, one application of DDT properly applied will give three or more years of effective protection in most cases.

Studies of natural control of the budworm on unsprayed areas were concentrated upon evaluating parasitism and were conducted on about the same scale as in the preceding two years. The total parasitism in 1953 was approximately the same as in 1952. Mortality among the overwintering larvae, due to unknown causes, exceeded the recorded parasitism on most areas. Natural mortality from all causes was not sufficient to indicate a general decline of the outbreak on unsprayed areas in 1954.

Information on the types of trees and stands preferred by the spruce budworm and on the effects of budworm feeding on individual trees and stands is needed to develop methods of control or prevention through forest managements. Work on this project was confined to setting up a cooperative study with the State of Oregon and outlining a proposed program to be undertaken in 1954.

Douglas-fir Beetle

A virulent outbreak of the Douglas-fir beetle developing in windthrown timber has been in progress in western Oregon and western Washington since 1951. It is continuing, but at a declining rate on most areas. A salvage-control program to utilize the insect-killed and windthrown timber and to reduce the beetle population was undertaken in 1952 and expanded in 1953. Research on the Douglas-fir beetle and special survey techniques provided the information necessary to develop and schedule the program.

In western Oregon and western Washington the Douglas-fir beetle is epidemic on 4,800,000 acres, a decline of 200,000 acres since last year. The volume of timber killed by the beetle is being estimated by aerial photo sample plots. Ground sampling showed 1½ billion board feet of blowdown during the winter of 1952-53 as compared with 9 billion feet the preceding winter. The down timber provides favorable breeding material for the beetle.

In eastern Oregon and eastern Washington epidemic infestations of the Douglas-fir beetle total 850,000 acres, more than double what it was last year. The most severe killing is in the Blue Mountains in stands repeatedly defoliated by the spruce budworm. In some drainages most of the sawtimber size Douglas-fir is being killed.

Studies of the Douglas-fir beetle in western Oregon have been in progress since 1946. In 1952 these studies were expanded through cooperation with entomologists and foresters of the Oregon State Board of Forestry and Weyerhaeuser Timber Company. Accomplishments during 1953 include the following:

(1) Many of the habits of the beetle in western Oregon and western Washington were worked out.

(2) Brood development was correlated with temperature and exposure.

(3) The host preference and brood productivity of various types of host materials were established.

(4) Yeast organisms associated with the Douglas-fir beetles were studied with regard to possible attraction for the beetle.

(5) Methods of tagging beetles with radioisotopes by feeding were studied and promising leads developed.

(6) Two species of clerid beetles and the larvae of a predacious fly were found to be effecting almost complete control of the Douglas-fir beetle in some localities.

Cooperative studies were continued in 1953 with the Division of Forest Disease Research and Weyerhaeuser Timber Company to determine the rate of deterioration of timber killed by the Douglas-fir beetle. A cooperative report of the findings is being prepared for issuance early in 1954.

Silver Fir Beetles

Silver fir beetles have killed silver fir extensively in Washington during the past five years. In 1953, the outbreak more than doubled in acreage. It now covers 603,000 acres. In some stands on the areas of heaviest damage, practically all of the merchantable silver fir is dead.

Studies of the character and extent of the damage were continued in 1953. The number of plots was increased through the establishment of additional plots on private lands by cooperators. The underlying causes of the outbreak have not yet been determined and no satisfactory control measures have been developed. Salvage of the dead and dying timber has been recommended and is in progress.

At the November meeting of the Northwest Forest Pest Action Committee a subcommittee was appointed to investigate the silver fir beetle problem. The subcommittee met in December at Seattle and formulated a program to determine the volume of dead and dying timber, to increase the salvage, and to speed up research.

Western Pine Beetle

In 1950, after a decade of normal activity, the western pine beetle again became epidemic in Oregon and Washington. The outbreak has steadily increased until now it covers one million acres, including some selectively cut stands. The Yakima and Warm Springs Indian Reservations and the Deschutes and Fremont National Forests are most seriously affected. A salvage control project is in progress on the Deschutes National Forest. Elsewhere sanitation-salvage cutting and regular harvest cuttings are being relied upon to control the outbreak.

A study to determine the effects of methods of cutting on mortality of ponderosa pine by the western pine beetle was begun in 1937. This study is scheduled to continue from 10 years to one entire cutting cycle, depending upon the area. The plots are cruised biennially and the data are summarized by decades. Until recently the plots have been subjected only to endemic bark beetle populations. Now, with an epidemic in progress, it will be possible to determine how different types of cutting affect mortality when the bark beetle population is high.

Plans for Forest Insect Research in 1954

The Division of Forest Insect Research(formerly of the Bureau of Entomology and Plant Quarantine and now of the Forest Service) will continue to have three main lines of work: research, surveys, and the technical supervision of control.

The division will continue research on the same major problems in Oregon and Washington, but with some change in emphasis to meet current needs. The total effort will be about the same as in 1953. Increased research by cooperators is expected. The following specific research jobs are planned:

1. Cruise the methods-of-cutting plots in ponderosa pine that were not covered in 1953. Summarize, analyze, and report upon the accumulated data. Determine what plots should be continued.

2. Continue and expand the present cooperative studies of the Douglas-fir beetle with special efforts to determine the causes of outbreaks, the role of natural control factors, host relationships, flight habits of the beetles, and possible control methods through management. Publish the findings to date.

3. Reactivate the silver fir beetle studies on a full-scale project basis. Continue and expand the mortality trend studies. Intensify the biological studies of the beetles and associated fungi. Study the rate of deterioration of the beetle-killed trees.

4. Continue the studies of spruce budworm population trends on both sprayed and unsprayed areas on the same scale as at present. Continue the study of parasites and expand the study of other causes of natural control.

5. Continue the studies to improve the effectiveness and safety of aerial spraying. Conduct laboratory and small-scale screening tests with insecticides other than DDT for spruce budworm control.

6. Undertake cooperative studies to develop spruce budworm control or prevention through forest management.

7. Complete interpretation and analysis of all photo samples taken to date. Rephotograph all permanent sample plots and analyze findings. Continue to develop and improve equipment for aerial surveys, with special emphasis on improving the strip viewer and the portable stereoviewer. Complete the aerial survey manual.

Surveys are fairly well standardized. No major changes are planned. As heretofore the success of the surveys will depend heavily upon cooperative help. The following jobs are scheduled:

1. Coordinate and conduct the division's share of the regional survey program in Oregon and Washington.

2. Resurvey the Douglas-fir region of western Oregon and western Washington to record the trend of the Douglas-fir beetle epidemic.

3. Enlist additional cooperation for all phases of the survey program. Special emphasis is to be given to the recruiting and training of aerial observers.

Technical supervision of control is dependent upon the availability of funds for spruce budworm control. Plans are ready to supervise the two control units recommended by the Northwest Forest Pest Action Committee.

FOREST DISEASE RESEARCH

Nursery and Plantation Studies

Fusarium root rot. Tests to control a serious Fusarium root rot of 1-0 ponderosa pine were continued at the Forest Service nursery at Bend, Oregon. A total of 16 different soil treatments and combinations were tried in quintuplicate plot tests. One series of plots was established in the fall and another in the spring. The treatments giving the best survival were as follows:

Fall application	Survival better than checks Percent
Sawdust + fertilizer + aluminum sulfate	113
Aluminum sulfate - 2 oz. per sq. ft.	104
Aluminum sulfate - 3 oz. per sq. ft.	92
Sawdust + sucrose	91
Aluminum sulfate - 1 oz. per sq. ft.	72

Spring application	Survival better than checks Percent
Sawdust and sod. Fluoride + aluminum sulfate	83
Sucrose	49
Sawdust + sucrose	41
Glucose + aluminum sulfate	30
Aluminum sulfate - 1 oz. per sq. ft.	25

A smaller series of plots using antibiotic organisms was also established in the spring but gave insignificant results.

Besides the numerical superiority of some of the treatments there was a significant difference in root system development. The roots of seedlings growing in the sawdust plots were bushier and contained a much better development of mycorrhizae than those growing on the aluminum sulfate treated plots. These tests will be continued for the second year and into the field as transplants.

A new series of test plots was also established in the fall of 1953 and will be followed by parallel treatments next spring.

Preliminary laboratory tests showed that the pathogen not only is capable of killing 1-0 ponderosa pine but those seedlings which survive

infection are definitely stunted. These tests were made possible by the cooperation of the personnel of the Deschutes National Forest.

Storage problems. The desirability of storing coniferous stock by refrigeration is well recognized. Studies were initiated in 1949 and have continued to date to determine the effects of cold storage on Pacific Northwest conifers. It was found for 2-0 Douglas-fir stock, dug in the fall, that periods of refrigeration longer than six months were generally undesirable. Ponderosa pine, noble fir, and Sitka spruce can be held in cold storage, however, for at least nine months without materially affecting field survival. No detrimental effect on the mycorrhizae has been noted. Seedlings packed in sphagnum moss showed more mold on their roots than those packed in washed shingle tow. Toxic substances in shingle tow also hold back root growth more satisfactorily for long periods of storage.

These are cooperative studies with the Forest Service nurseries at Bend and at Wind River, and with the Division of Forest Management Research of the station.

Mycorrhizal studies. The object of these studies is to determine the importance of mycorrhizae to Pacific Northwest conifers. The development of mycorrhizae, as already noted, may be greatly influenced by soil treatments. Field tests have shown that 2-0 ponderosa pine with mycorrhizae show a significantly higher survival than similar seedlings without mycorrhizae. Differences in seedling growth in field plantations remain to be determined.

The survival of natural Douglas-fir seedlings on burned and unburned soil may be related to the occurrence of mycorrhizae. It has been found that for one-year-old seedlings, a significantly higher percentage had mycorrhizae in unburned areas than on burned areas. These studies are being continued and in addition an attempt will be made to determine the importance of damping-off in burned and unburned soil. These factors, together with others already known, may all contribute to the frequent failure of natural regeneration on burned areas, where the soil has been sterilized by intense heat. Parallel laboratory studies are being made as required. The mycorrhizal projects are cooperative with the Deschutes National Forest and the Division of Forest Management Research.

Needle Blight of Ponderosa Pine

Rapid and extensive killing of merchantable trees, fairly common during the first few years of the current outbreak, is now apparently occurring in only one or two localities. Elsewhere, damage now consists principally of destruction of large portions of the crowns of severely infected trees and their consequent conversion from good risks to poor risks. The volume losses that will result directly or indirectly from current infections are potentially at least as heavy as those experienced during the late 1940's, but these losses are now gradual enough to permit salvage of most of the affected material. Salvage costs should be reduced by cutting badly infected trees during ordinary logging operations.

Permanent plots on the Ochoco, Malheur, and Whitman National Forests will be re-examined in 1954, and work will be extended to include trees in younger age classes. A show-me trip on the John Day Experimental Forest for representatives of pine companies, to familiarize them with the appearance of stands having various intensities of blight infection, is planned.

Ponderosa Pine Mistletoe

Patterns of spread. Studies were made at the Deschutes Research Center in cooperation with the Oregon State Board of Forestry to obtain information on distance and direction of spread of mistletoe seeds. It was found that intensities of infection in reproduction were not necessarily related to either the areal extent of infection or the degree of deformity of overstory crowns. Dispersal of mistletoe seed was measured by seed trapping, but data have not yet been summarized. Several trees were observed that appear to be resistant to mistletoe; grafts from these will be tested in the future.

Killing mistletoe by sprays. One of the most difficult problems in the control of pine mistletoe is to save already infected reproduction. Branch pruning can be used only to a limited extent. The ideal would be to find a differential spray that will kill the mistletoe without killing the tree. With this as an object, a small series of plots was established in the Pringle Falls Experimental Forest in 1952. Using esters of 2,4-D and 2,4,5-T the following results have been obtained:

(1) Ponderosa pine saplings can be killed by these sprays only if the foliage receives thorough coverage.

(2) Spraying the main stem of ponderosa pine has no noticeable detrimental effect on the tree.

(3) Thorough spraying of the foliage on an individual branch will kill the branch without killing the tree.

(4) These sprays kill the mistletoe shoots but they generally sprout again the next season.

These studies are being continued in cooperation with the Deschutes Research Center and the Blister Rust Development and Investigation unit of the California Region, Forest Service.

Blister Rust Studies

Susceptibility tests of 5-needled hybrid pines. In April 1946, 36 trees were planted, representing crosses as follows: *Pinus strobus* x *P. excelsa* (12), *P. monticola* x *P. excelsa* (12), and *P. monticola* x *P. strobus* (12). These were planted in the division's white pine species relative susceptibility test plots near Rhododendron, Oregon, where excellent pine infection conditions exist. Hybridizing of these trees was by the Institute of Forest Genetics, Placerville, California, and the

field trials were requested by them to test the rust resistance as well as the silvicultural qualities of the hybrids. The following table shows examinations and combined results of the 1949 and 1951 examinations.

Results of Tests of Hybrid 5-Needled Pines at Rhododendron, Oregon

	Trees infected		Trees healthy		Trees killed		
	No.	%	No.	%	No.	%	
P. monticola x P. excelsa	9	75	3	25	4	33	
P. monticola x P. strobus	11	92	0	-	5	42	(one missing - stolen)
P. strobus x P. excelsa	3 1/	25	7	58	1	8	

1/ Two additional trees infected but not by blister rust (probably Phomopsis spp.), one of which died.

Rust infection resistance of white pine grafts. The Spokane Office of the Division of Blister Rust Control sent to this division for out-planting 12 grafted white pines in May 1951. These were grafts of twigs from presumably rust-resistant white pines on nursery-grown white pine seedling root stocks. Planting of grafts and of 36 seedling check plants was by a randomized system standardized for plantings at many locations throughout the United States. Object of tests to determine whether these grafts exhibit the same resistance to white pine blister rust as did the rust-resistant trees from which the scions were taken. This local planting is in this division's white pine species relative susceptibility test plot near Rhododendron. Sufficient time has not elapsed for infections to appear but these should become apparent by the spring of 1954 or 1955. Each year since planting the trees have been released by removing the bracken and other competing vegetation.

Decay of Windthrown Timber

Measurements in five different localities in western Washington and western Oregon show that temperature is one of the major factors determining rates of decay of down trees in this region. Although the data obtained thus far are insufficient to permit reliable conclusions, a progress report was published in multilith form to facilitate salvage of the great volume of timber windthrown in late 1951. During the next 10 years, additional data will be obtained from 1951 windthrows.

Decay of Beetle-killed Douglas-fir

This study was undertaken two years ago in cooperation with the Division of Forest Insect Research, the Weyerhaeuser Timber Company, and the Gifford Pinchot National Forest. A joint progress report was prepared

covering the work done in 1952. Since then additional data have been obtained from several other areas in Washington and Oregon. These data have not yet been tabulated. It seems evident, however, that decay of the sapwood will be so rapid that it will be necessary to log beetle infested trees by the end of the second year if the sapwood is to be used for lumber. If the beetle-killed trees are to be utilized for chips, an additional year will be allowable before logging. The heartwood does not show significant decay until after four years. On individual trees there is a strong correlation between location and intensity of attack by the Douglas-fir beetle and subsequent decay. Fomes pinicola appears to be the chief agent of decay during the first two years after death.

Root Rot of Douglas-fir

During the 1953 field season an intensive survey on the Gifford Pinchot National Forest was made of portions of a fairly representative site III Douglas-fir stand about 110 years old. On several quarter-sections, root rot losses were light enough to require little or no special consideration in management plans. On one block of 3 quarter-sections, however, Poria weirii had destroyed 5.2 percent of the stand, or somewhat more than one million board feet. It was estimated that P. weirii damage on this block is now occurring at an average rate of about 200 board feet per acre per year, or approximately one-half of the current average annual gross increment.

Poria weirii causes more than four-fifths of the total damage by root rot to Douglas-fir. This fungus characteristically occurs in centers of infection, where it spreads from tree to tree through the roots. It was found that these centers of infection tend to be grouped, with the groups often separated from each other by several hundred feet of forest containing little or no infection. Advantage can be taken of this condition by planning logging operations so that the first settings include the heaviest concentrations of root rot. Preliminary analysis of last summer's data indicates that on the three most heavily infected quarter-sections P. weirii losses could be reduced at least 80 percent by logging about 40 percent of the area. In other words, clearcutting less than half of the area would result in salvage of the values now present in those parts of the stand that are static or decreasing in volume, and would leave undisturbed most of the area that is still producing reasonably satisfactory increment.

Further surveys will be made in 1954. Permanent plots will be re-examined and additional plots established, in cooperation with Crown Zellerbach Corporation, Port Blakely Mill Company, and Weyerhaeuser Timber Company.

Port-Orford-Cedar Root Rot

A killing root rot of Port-Orford-cedar caused by Phytophthora lateralis has been present west of the Cascades in the Pacific Northwest for years. Until recently it had not been found within the natural range

of Port-Orford-cedar. It has now been identified in Coos County, and because of this presents for the first time a potential threat to Port-Orford-cedar stands. A complete survey of such stands has not been made but is planned for the near future. The survey will be in cooperation with the Department of Botany and Plant Pathology of Oregon State College and the Siskiyou-Cascade Research Center.

Decays and Stains of Forest Products

On-the-job treating tests. Two of these tests were established last year at Corvallis in cooperation with the Oregon State Forest Products Laboratory, West Coast Lumbermen's Association, Western Pine Association, and the U. S. Forest Products Laboratory, Division of Forest Disease Research.

One test consists of surfaced 2x4 angle units of western hemlock, ponderosa pine, and Douglas-fir. One-half of the number were dipped in pentachlorophenol and the other half left undipped. All were painted with white lead. These units are arranged above the ground on 4-foot high posts and exposed to the weather. They simulate porch rail construction.

The other test is a series of tongue and groove floor panels placed on creosoted 2x4 frames resting on the ground. The woods used were: Douglas-fir, western hemlock, white fir, ponderosa pine, western red cedar, and southern yellow pine. The treated flooring was dipped in pentachlorophenol, in penta. W.R., or in copper napthanate. Some of the panels were painted with gray flooring paint. All are exposed to the elements.

The object of these tests is to compare the different lumber species for susceptibility to decay and to demonstrate the benefit of on-the-job treatments and painting in retarding the development of decay. In addition, the treatment of the little-used lumber species, such as white fir and hemlock, should encourage wider usage.

This is a long-time project and will require annual examinations for a number of years. During the first year no decay has developed but there has been molding of the undersurface of some floor units. A record of the weathering of the paint has been made for future reference.

Penetrability studies. Douglas-fir is a difficult species to impregnate with preservatives and even under pressure does not treat readily. Trichoderma mold has been used to increase penetrability. Last year freshly felled Douglas-fir saplings were cut into 4-foot lengths and treated as follows:

20 pieces sprayed with a 3 percent solution of sodium fluoride.
20 pieces sprayed with 3 percent solution of sodium fluoride in which Trichoderma spores were suspended.
20 pieces sprayed with double strength Dowicide G.
20 pieces untreated.

After several months incubation it was found that Trichoderma mold had developed profusely on all but the Dowicide G sprayed poles. Immersion of the molded and bright poles in a petroleum oil showed that the oil penetrated from 1/4 to 1/2 inch in the molded poles but only 1/8 inch in the bright unmolded poles. Further tests using pressure treatment will be tried later. This test is established in cooperation with the Oregon State Forest Products Laboratory and the U. S. Forest Products Laboratory, Division of Forest Disease Research.

Field study of fungi causing decay of treated wood. Laboratory tests have shown that some wood rotting fungi are more tolerant to certain chemicals than to others and similar but only limited evidence has been obtained for wood in service. For this reason two stake plots of treated southern yellow pine were established at Corvallis last year. A number of different preservative treatments were used. There are 6 to 10 replications of each treatment. One plot is in an open field and the other within a forest plantation. Annual inspections are to be made and the fungi isolated as soon as decay becomes evident. This is a cooperative project with the Oregon State Forest Products Laboratory and the Division of Forest Disease Research of the U. S. Forest Products Laboratory.

Decay of pulp chips. This project was initiated by the station's Forest Utilization Service and has been carried on in cooperation with the Fir-Tex Company of St. Helens, Oregon. The question is will mixing alder with Douglas-fir chips for long periods of storage hasten decay of the latter. Several small piles of chips were established from which samples were taken each month. It was found that while alder chips do decay more rapidly than Douglas-fir, mixing the two does not increase the decay hazard for Douglas-fir. Mixed two-thirds alder with one-third Douglas-fir chips can be left safely in outdoor piles for a year.

Decay of Aircraft Carriers and Small Boats

This project has been carried on in cooperation with the United States Navy's Bureau of Ships and the U. S. Forest Products Laboratory, Division of Forest Disease Research. The Pacific Northwest part of the project has taken the major portion of one man's time for the past year. Although this man has now been transferred to the Madison Laboratory, the work done in the Northwest was largely at the expense of other local projects and should be reported here. Tests have been established to determine the feasibility of treating the flight decks of out-of-service aircraft carriers in situ to prevent decay. A study of the decay of the Navy's small stored motor craft has also been made and recommendations for the prevention of deterioration have been given the Bureau of Ships. Local participation in these Navy projects will be discontinued next year.

Building Decay Studies

A number of dwellings with building rot have been examined at the request of the owners during the past year. Contact of the joists, either directly or indirectly, with the soil and lack of adequate ventilation

bring about the rapid development of decay. The largest building inspected was the Rainier, Oregon, Grammar School. This building was constructed three years ago but because of inadequate ventilation and faulty construction the north end of the joists under the gymnasium floor was so badly decayed as to present a safety hazard. Suggestions were made for providing adequate ventilation and suitable repairs.

Our three housing units at the St. Johns Woods Housing Project were inspected again this year and it was found that water of condensation and decay is still being held in check by building paper installed three years ago as a ground cover. It is planned to continue these inspections as required.

Plans for Forest Disease Research in 1954

Planned activities on the following problems are intended primarily to obtain disease and decay information that will permit recovery of most of the values involved through alterations in the pattern of harvesting operations, and eventually lead to control through modifications in management practices, encouragement of competitive or antagonistic organisms, and development of resistant trees.

1. Nursery and plantation diseases are of primary importance because of the tremendous extent of the reforestation job required to put the forest lands of this region into maximum productivity.

2. Root diseases are a constant source of loss, especially in young Douglas-fir stands. Phytophthora in Port-Orford-cedar stands is a new and potentially very destructive member of this group of diseases.

3. Elytroderma needle blight of ponderosa pine is now at or near the peak of one of its cycles of abundance, and is not only causing serious losses in some localities but is also disrupting pine management plans.

4. Decay of insect-killed timber, especially of Douglas-fir and silver fir, is at present of great interest to the logging industry because of heavy mortality of these two tree species during the last few years.

5. Blister rust on sugar pine in southern Oregon is threatening extensive and valuable stands where this tree species is by far the most productive. A cooperative study with the Blister Rust Development and Investigation unit, California Region, Forest Service and the Siskiyou-Cascade Research Center is necessary to solve numerous difficulties that are complicating control on the Rogue River Forest. Studies of the epidemiology of rust on sugar pine throughout the type in southern Oregon are urgently needed by the Division of Blister Rust Control.

6. Dwarf mistletoe on ponderosa pine, western hemlock, and other conifers, is a constant cause of damage in many stands.

7. Decays and stains of forest products not only increase the drain on our forest resources but also cause prejudice against the use of wood because of the high replacement costs involved when wood fails in service.

These activities have been discussed in general terms since this is the first time that a section on forest diseases has appeared in this report.

RANGE RESEARCH

Range research effort in 1953 centered mainly on summer range problems in eastern Oregon and eastern Washington with the objective of completing physical facilities for the Starkey grazing management study, and reviewing on the ground all reseeding studies established in recent years. Office analysis of the summer's field data was seriously delayed by the transfer of Robert S. Rummell to Florida in October and the detail of Clark E. Holscher to the Food and Agriculture Organization of the United Nations in Rome in late November. Holscher is serving as a consultant in the preparation of plans for a technical meeting on forest grazing to be held in Rome in the spring of 1954. The range research program also will have to be reoriented owing to the transfer of reseeding research to Agricultural Research Service in December.

Assistance was given to National Forest Administration on the field clinic on the Ochoco National Forest, where water development, livestock distribution, herbage utilization, and grazing capacity determination were discussed in the light of research results. The development of additional condition and trend standards was continued. Range research assisted in the training of national forest personnel in the establishment of condition and trend transects.

Range research personnel participated in the work of the cooperative interregional committee dealing with the interstate deer herd which migrates between Oregon and California. Assistance was given in each of the annual field inspections by the Oregon and Washington livestock advisory committees. Range research results were presented at the summer and fall meetings of the Northwest Section of the American Society of Range Management. Aid also was given in the selection of the stockmen of the year for Oregon, for Washington, and for the tri-state area of Oregon, Washington, and Idaho.

Other cooperative efforts included preparation of reports and participation in the plans formulated by the Forest Service Range Reseeding Committee at Albuquerque, New Mexico, and cooperation with the Washington State Department of Game on development and use of techniques for measuring browse utilization on game ranges.

Grazing Management Studies

Emphasis in grazing management research continued to be in developing physical facilities for the Starkey grazing study. Major accomplishments during 1953 were:

(1) Completion of fences and water developments needed for the second block of six experimental pastures.

(2) Completion of grazing capacity calibration on one block of six pastures and the initiation of calibration on the second block of pastures.

(3) Establishment of permanent plots needed to sample herbage production, herbage utilization, ground cover, plant development, and forest tree reproduction in all of the experimental pastures.

(4) Preparation of a working plan, establishment of permanent plots, and initial collection of records for a study of the effects of different dates and intensities of harvest on elk sedge (Carex geyeri).

(5) Addition of 3,000 acres of national forest land to the Starkey Experimental Forest and Range, which allows the use of cattle from one permittee on all of the experimental pastures.

The outstanding results and conclusions from field work, and from analysis of data collected during 1952, are presented below.

Proper salting, adequate water developments, and good range riding produced good distribution of cattle and uniform forage use. Utilization of bluebunch wheatgrass (Agropyron spicatum), the most important forage species on grassland range, varied from 41 to 55 percent on Starkey key areas in 1952 (table 1).

Table 1.--Utilization of major forage species on five grassland and open forest key areas in 1952

Type and species	Key area				
	Meadow Creek	Bear Creek	Campbell	Burnt Corral	Big Flat
	Percent	Percent	Percent	Percent	Percent
Grassland					
Bluebunch wheatgrass	52	46	55	41	46
Idaho fescue	47	--	64	51	--
Prairie junegrass	40	--	60	--	50
Onespike danthonia	45	--	49	36	27
Sandberg bluegrass	20	20	26	20	20
Open forest					
Elk sedge	46	35	39	14	39
Pinegrass	38	28	23	10	27
Bluebunch wheatgrass	45	--	42	--	38
Idaho fescue	53	30	50	10	--

Utilization records were collected from five grassland and adjacent open forest key areas representing range types which in the past had received heavy, average, and light use. Good range riding and salting were responsible for achieving 41 percent use of bluebunch wheatgrass on the Burnt Corral area, which normally receives very light use because of steep topography, distance from water, and difficulties in getting cattle moved into the country. The Big Flat area, ordinarily used very lightly because of lack of stock-water, received 46 percent use on bluebunch wheatgrass. The increased use was due largely to the development of three bulldozer and one Colville-type water developments on the area in June 1952. The Campbell key area, where cattle usually concentrate because of choice forage, gentle topography, and adequate water, received only 55 percent use on bluebunch wheatgrass. During the 1940-49 period the average use for this species on the same range type was 66 percent. The amount of use was controlled each year by distributing small groups of cattle in remote areas when they were first placed on this range unit, and by salting away from the area until near the end of the grazing season.

The utilization of elk sedge and pinegrass in the open forest was 10 to 15 percent higher in 1952 than during the 1940-49 period. This may be attributed to two factors: (1) salt was distributed at 53 open forest salt ground locations in 1952 as compared to 26 locations during the 1940-49 period; and (2) extremely dry conditions during August and September causing the cattle to seek the greener and more succulent forage in the open forest.

Stock-water on Blue Mountain summer ranges is where you develop it--not where you find it. This was proved during a water development program on the Starkey Experimental Forest and Range in 1952. Fifteen waterholes were constructed with a bulldozer in three days at a total cost of $250, an average cost of less than $17 per waterhole. In addition, approximately six miles of abandoned logging roads were cleared of logs while moving between waterholes, providing trails for natural movement of cattle as well as driveways for moving cattle to obtain better distribution. The total distance traveled by the bulldozer in the construction of these waterholes was 30 miles.

Only three of the holes constructed had previously been considered as potential water developments. Five waterholes were found by digging near ridgetops where native water-loving vegetation indicated a possible underground water supply. Two of these five holes provided water season-long, while the other three provided temporary water for approximately 60 days. Seven waterholes were obtained by excavating three or four feet in drainage channels and bringing underground flows to the surface. All of these 15 holes provided season-long water in 1952 and 1953. Sites for these excavations were selected at the end of the spring runoff period by noting the last places in the channels which dried up.

At the beginning of the water development program on the Starkey range in 1949, there were 9 trough developments in existence on the 24,000-acre range. Fifteen other springs were considered as potential

developments. There are now 45 water developments on the range, 21 more than were considered possible four years ago. In addition, there are at least 10 to 15 additional sites where water could be developed to improve distribution and provide more efficient use of forage.

First year of calibration on experimental pastures shows uniform cattle weight gains. Weight gains of 113 calves on six moderately grazed pastures averaged 203 pounds per head during a 110-day grazing season, increasing from an average of 226 pounds on June 5 to 429 pounds on September 23. The maximum difference in gain between pasture averages was only 10 pounds per head. The average daily gain was 1.85 pounds per head.

Weight gains of cows were less uniform than gains for calves. Cows in four pastures showed average gains which ranged from 67 to 73 pounds per head, while cows in the other two pastures gained 57 and 47 pounds per head. An analysis based on final weights showed no significant difference between the average final weights for any of the pastures. The average initial weight of the cows on all four pastures was 952 pounds per head, and at the end of the season, 1,013 pounds. The average daily gain was 0.55 pounds per head.

Cooperation has speeded progress in grazing management on the Starkey Experimental Forest and Range. Cooperation of the stockmen who furnish cattle for the Starkey, and their range rider, has been especially helpful. At their 1953 annual meeting a working agreement between the station and their association was approved unanimously, insuring the continuation of the management and research program in the event of personnel changes in either the station or the association.

This agreement provides (1) a flexible opening date for grazing on the range based on soil and vegetation readiness; (2) for salting and the initial distribution and movement of cattle throughout the grazing season; (3) use of association cattle in grazing studies in accordance with prescribed management plans; and (4) a division of responsibility for the maintenance of range improvements.

The helping hand given by many other individuals and organizations, including the Starkey Cattle and Horse Association, First Union Soil Conservation District, Soil Conservation Service, Oregon State Game Commission, Mt. Emily Lumber Company, and the Whitman National Forest, has contributed to the development of the research program and the physical plant on the Starkey Experimental Forest and Range. This aid has made our efforts to improve range and watershed easier and more productive.

Range Reseeding Studies

The major accomplishment during the year was the summarization of reseeding information into a manuscript to be submitted as a USDA Circular. This manuscript, entitled "Reseeding Summer Ranges in Eastern Oregon and Washington," will be submitted to the Washington Office early in 1954.

Woodchip mulches improved water-holding capacity of scabridge soils and resulted in better stands of seedling grasses. Plots treated with woodchips were moist at the soil surface on July 9, 1953, approximately four weeks after the last effective rainfall, while untreated plots were dry at the surface.

Woodchip mulches with and without fertilizer were applied to one-quarter acre plots on the Umatilla National Forest in October 1952, to test their value in establishing stands of reseeded grasses and in improving soil condition and productivity. The woodchips were applied at depths of one-half and one inch, (1) as a mulch, with and without ammonium sulfate added, and (2) disked into the soil with ammonium sulfate added. All plots were broadcast seeded to a mixture of pubescent wheatgrass, timothy, and hard fescue.

Untreated plots produced very poor stands of all species while plots treated with woodchips alone produced stands which were rated as poor to medium. Stands which rated from medium to excellent were produced on plots treated with woodchips and ammonium sulfate.

Seedlings on plots treated with woodchips and ammonium sulfate were large, well-rooted, and vigorous. Seedlings on plots treated with woodchips alone were not as large and well-established. With small-seeded species like timothy, a one-half inch mulch produced twice as many seedlings as the deeper mulch. This was probably due to the lack of seedling strength to push through the greater depth. Disking chips into the soil produced the highest number of seedlings for timothy and hard fescue while a one-inch mulch provided the highest number of seedlings for pubescent wheatgrass.

Once-over tillage with the Rockland tiller on rocky scab ridges was nearly as effective in tarweed control as twice-over tillage. In July 1951, approximately 10 acres of rocky land west of Lucky Strike lookout on the Umatilla National Forest was cultivated with the Rockland tiller. Tarweed counts in July 1952 showed an average of 2.3 plants per square foot on areas tilled twice-over and 2.8 plants per square foot where tillage was only once-over.

Twice-over tillage, however, produced slightly better seeding stands of planted grasses than did once-over tillage. Ten species of grass were broadcast seeded on the areas in October 1951 on 6 inches of snow. Ratings of these grasses in July 1952 showed medium to excellent stands of all species. On once-over tillage 5 species rated good and 5 medium. On twice-over tillage 3 species produced excellent stands, 4 good, and 3 medium. Species which produced good stands or better were: intermediate wheatgrass (Agropyron intermedium), P-14 and P-2327, pubescent wheatgrass (A. trichophorum), orchardgrass (Dactylis glomerata), timothy (Phleum pratense), hard fescue (Festuca ovina duriuscula), and Manchar smooth brome (Bromus inermus).

Species adaptability trials in the sagebrush-grass zone in Washington have shown consistently high ratings for intermediate wheatgrass. Study of 15 carefully selected species has been made since 1946 on the Doneen area in Douglas County. The study site is located on abandoned wheatland which was densely covered with cheatgrass brome when the original plantings were made. The site is located on Ritzville soils and is fairly productive under 10 to 11 inches of annual precipitation.

Initial plantings were made on prepared seedbeds in the fall of 1946. Other plantings were made each spring and fall through the spring of 1949. The fall 1946 and spring 1947 plots were broadcast seeded. All other plantings were single-disk drilled. Each summer ratings were made for all species.

While several grasses have done well on the Doneen area, intermediate wheatgrass has consistently rated highest when all seasons of drilling are averaged. It has even done moderately well from plantings made in the dry spring of 1949. Contributing to its success on the Doneen site is its ability to make fast seedling growth. In plots where intermediate wheatgrass has made good stands, very little cheatgrass brome appears. In 1952, intermediate wheatgrass averaged 7.9 (good) for all dates of drilling (table 2).

Other grasses which have done very well on the Doneen study are beardless bluebunch wheatgrass (A. inerme) Whitmar, big bluegrass (Poa ampla), and pubescent wheatgrass. Both crested wheatgrass and Siberian wheatgrass (A. sibiricum) P-27 have done only moderately well when all seasons of drilling are considered. However, both of these wheatgrasses have produced good stands in plots planted in the fall of 1947 and spring of 1948.

Stands produced by bluebunch wheatgrass (A. spicatum) P-737 from plantings made in the spring of 1948 averaged good in 1952. Its other stands rated only fair to poor.

Several species have failed to make good average stands on the Doneen Species Trials over the years. These include tall wheatgrass (A. elongatum) P-2326, western wheatgrass (A. smithii) P-9373, meadow brome (Bromus erectus) Comm., Canada wild-rye (Elymus canadensis) Comm., Russian wild-rye (E. junceus) Comm., Indian ricegrass (Oryzopsis hymenoides) Comm., and bulbous wheatgrass (Poa bulbosa) Comm. The majority of these rated poor, or were failures.

Table 2.--Relative ratings in 1952 of species on Doneen Species Trials classed by date of drilling with average ratings

Species	Accession	Date of drilling: Fall 1947	Spring 1948	Fall 1948	Spring 1949	Average
Agropyron cristatum	Std.	7.5[1/]	8.5	5.5	1.5	5.8
" elongatum	P-2326	4.5	6.5	4.5	1.0	4.1
" inerme	Whitmar	9.0	10.0	8.0	4.0	7.8
" intermedium	P-2327	8.5	8.5	7.5	7.0	7.9
" sibiricum	P-27	8.5	8.5	5.5	1.0	5.9
" smithii	P-9373	1.5	1.0	0	0	0.6
" spicatum	P-737	6.0	7.5	3.0	1.0	4.4
" trichophorum	Topar	8.5	8.5	6.5	5.0	7.1
Bromus erectus	Comm.	4.5	5.5	4.0	2.0	4.0
Elymus canadensis	Comm.	1.0	2.0	0	0	0.8
" junceus	Comm.	3.5	5.0	0	0	2.1
Medicago sativa	Ladak	1.0	2.0	2.0	2.5	1.9
Orysopsis hymenoides	Comm.	0	0.5	0.5	0	0.2
Poa ampla	Sherman	10.0	8.5	8.0	3.5	7.5
" bulbosa	Comm.	0	0	0	0	0

1/ Rating of 10 is excellent; 0 is failure.

Range Condition and Trend Studies

Proper recording of seedlings of perennials has proved to be a vital detail of the three-step method of measuring range condition and trend. Recording of seedlings by special symbol and not as mature plants for inclusion in floristic composition is, of course, required by present transect instructions. Such a precaution had not been developed when the first loop transects ever established were under trial in early summer of 1949 on eastern Oregon grasslands. These transects, when reinventoried in 1952, showed a loss of perennial grasses. It is quite possible that the 1949 transect inventory readings were "inflated" by the good grass seedling stand of 1948-49. During the subsequent droughty season, the seedlings may well have perished and thus produced an apparent downward trend in range condition. Attention to this seemingly minor detail of properly recording seedlings is deserving of emphasis if indicated trends are to stand unchallenged.

Nearest hit modification to the loop or ring transect has been shown by a methods study to provide lower sampling errors for composition inventory and better information on the occurrence of secondary species than the

unmodified loop method of measuring range condition and trend. The "nearest hit" technique, recently recognized as a standard modification for the loop transect, provided sampling errors which were 10 to 72 percent lower than the plain loop procedure. The modification consistently provided 100 observations per transect for computation of floristic composition. Furthermore, twice as many species were recorded with the nearest hit technique as were recorded under the unmodified loop method. Improvement of information on composition was needed for certain sparse cover types of eastern Oregon and Washington.

Under neither technique did differences between observers become significant; however, familiarity of the observers with the flora reduced the likelihood of personal error from one of the most common causes, misidentification of species.

The third transect method included in the trials, one requiring the use of 1/4-square-foot plots, compared very favorably with the nearest hit technique.

Site classification studies were initiated in 1953 to meet the needs of the new three-step method. Any method of range condition measurement is to some degree concerned with site classification, since by definition range condition expresses departure from potential for a given site. But site classification requirements for the three-step method cannot be met by merely delineating the range into broad vegetative types. Instead, soil and site characteristics of specific transect locations must be taken into account. This requires study and classification of soil and site variations within a range type, lest vegetation responses to soils and sites be confused with vegetation responses to grazing.

Basically the task is "correlating vegetation with soil and site." Vegetation is inventoried by the modified loop or ring transect. A standardized examination is made for soil and site with particular attention to those characteristics having a strong effect on soil moisture supply. Laboratory checks are made of soil textures. Site class descriptions are not being supplemented with maps and no mapping is contemplated.

Non-forested ranges or grassland openings are receiving first attention in eastern Oregon. To date, three bunchgrass site classes and one meadow site class have been described. In the subalpine grasslands, some evidence has been acquired which indicates that at least two site classes can be delineated.

Condition standards adapted to the three-step method have been prepared for each important site studied and revised schemes have been proposed for recording data and for scoring range condition.

Interrelationships of Timber and Forage Production

Coverage by understory plants on areas disturbed by logging but not badly compacted was regained by the fourth summer after logging in Oregon pine forests. Rate of range plant recovery for all logged areas and in all years was not uniform. As previously reported, understory vegetation actually exceeded the amount of prelogging cover on one study area by the fourth summer after logging. However, on the average the amount of ground cover was just restored in four seasons.

Restoration of ground cover in terms of quantity does not mean complete restoration of grazing and watershed values in such a short time. Forage for cattle remained below prelogging quality because of the low proportion of grass and high proportion of broad-leaved herbs. These weeds or broad-leaved herbs frequently dry and shatter by the first part of August. Grasses are also usually superior to broad-leaved herbs as year-round watershed cover.

Natural recovery on logging roads, landings, and once heavily used skid trails was found to have made little progress by the fourth summer after these works were abandoned. Most of these badly compacted areas have remained barren or only have a cover of annuals.

Reseeding of logging disturbed areas on ponderosa pine ranges of eastern Oregon and eastern Washington is increasing in use by private timber owners and public forest administration. Reasons for reseeding to grass are:

(1) Prevention of soil erosion.

(2) Prevention of invasions by highly inflammable or noxious plants.

(3) Restoration of grazing values in less time than required by the process of natural recovery.

Effect of Pocket Gophers on Reseeded Stands

Pocket gopher preference for tall oatgrass over three wheatgrasses has been shown in a study of gopher effects on new grass stands in eastern Oregon. Dalles pocket gopher invasion and damage of newly established stands of three wheatgrasses (*Agropyron intermedium*, *A. trichophorum*, and *A. cristatum*) was almost nil during the first three growing seasons. Lack of gopher invasion was at first attributed to seedbed preparations which destroyed all broad-leaved herbs preferred by gophers. "Cleanliness" of new seedbeds, however, did not prove to be a deterrent to gopher activity after the first growing season for a strip planting of tall oatgrass (*Arrhenatherum elatius*). This species had been planted at the same time and adjacent to strip plantings of the wheatgrasses in a 1.1-acre plot. During the second and third growing seasons, 14 percent of the oatgrass stand was taken by gophers.

In the fourth growing season, pocket gophers also began invasion of the wheatgrass stands. By the fifth growing season the average stand losses by wheatgrasses was 30 percent, whereas stand loss of tall oatgrass had increased to 84 percent.

Pronounced susceptibility of young grass plants to gopher damage was also indicated in our previous reports on a crested wheatgrass stand during its tenth to fifteenth growing seasons. Significant damage by gophers during that period was done to young grass plants becoming established in the 3-foot strips between old drill row plantings.

This gopher study is a cooperative project with U. S. Fish and Wildlife Service and joint publication of results is contemplated.

Big Game Livestock Relationships

Two manuscripts from the management phase of this station's browse studies were published in March and September 1953 issues of the Journal of Range Management. The first was entitled "Annual Fluctuation in Production of Some Eastern Oregon and Washington Shrubs," and the second was "Effects of Clipping on Some Range Shrubs."

Cooperation was continued with the Interagency Browse Committee, which has been formed for the States of Oregon and Washington. Some assistance was given to the Washington Game Department in their planning of shrub clipping studies. Aid to the station in setting up game pellet count work in Starkey experimental pastures was given by the Oregon State Game Commission.

Plans for Range Research in 1954

The transfer of reseeding research to Agricultural Research Service will necessitate some changes in emphasis in certain phases of range management research now in progress. Needed changes will be based on problem analyses for the Blue Mountain and Mid-Columbia Research Center Provinces.

Publications planned for completion include the USDA Circular on "Reseeding Summer Ranges in Eastern Oregon and Eastern Washington" and a magazine article on techniques for studying browse plant production. Arrangements have been made for George Garrison to be co-author with Miss Doris Hayes of the Washington Office of a "Key to Important Woody Plants of Eastern Oregon and Eastern Washington."

On the Starkey Experimental Forest and Range, two systems of management, deferred-rotation and season-long, and three intensities of stocking, will be applied to the pastures in block I. Cross-fences for the deferred-rotation pastures in this block are scheduled for completion by June 1, 1954. Pastures in block II will receive the second year of calibration treatment. Cross-fences for the deferred-rotation pastures will be surveyed and constructed during the year.

The first inventory of herbage production and ground cover will be made on the pastures in block I. A forage utilization inventory will be made in all pastures at the close of the grazing season. The second of four years of harvesting treatments will be applied to elk sedge study plots established in 1953.

Publications during the year will also include a guidebook describing the Starkey Experimental Forest and Range. A manuscript entitled "Fluctuations in Forage Utilization on Ponderosa Pine Ranges in Eastern Oregon" will be submitted to the Journal of Range Management early in 1954. An illustrated article describing the construction of water developments will be prepared for publication in the Oregon Cattleman. An article presenting an analysis of the 1953 cattle weight measurement will also be prepared for either station or trade journal publication.

Range condition and trend studies will be continued in eastern Oregon and new condition and site studies will be initiated in eastern Washington.

Plans for 1954 also call for the construction of two game study pastures of approximately 100 acres each in size at the Starkey Experimental Forest and Range. Permanent plots will be established in these pastures for the collection of game utilization and pellet group data. Since work has been concluded and publications prepared on most of the outlying game-livestock forage studies, a new program for this phase of range management research is under consideration. It is hoped that cooperation from other agencies can be obtained in the new projects.

FOREST ECONOMICS

Demands for special information to service production of forest materials needed in the defense program have become practically routine. Likewise the demands upon time of Survey personnel through repetition of the Blowdown-Bark-Beetle Survey of the Douglas-fir Subregion initiated in 1952 were much less than the preceding year. Techniques had been worked out and the epidemic was less widespread than during 1952.

Satisfactory progress was made in integrating the Timber Resource Review tasks V, VI, and VII with other work of the Forest Survey. As a result the Timber Resource Review aspect of the job has been progressing on schedule. At the same time greater field progress was made in survey reinventories than in any year since 1948. A total forest land area of 4.0 million acres was covered. Unit costs of operation were reduced over previous years despite a general increase in prices of material and services.

Other activities in the field of forest economics were relatively minor. They consisted of consultation in forest taxation, forest credits, and general economic resource analyses with various agencies and individuals.

Forest Survey

During 1953 field reinventories were completed in Deschutes, Jefferson, Wheeler, and Harney Counties in eastern Oregon and Kittitas County in eastern Washington, a total forest land area of 3,952,275 acres. With this work eight counties in the ponderosa pine subregion representing 38 percent of the forest land and roughly 50 percent of the sawtimber volume have been completed. The county type maps were completed for Lewis and Grays Harbor Counties in Washington and Clatsop and Crook Counties in Oregon and made available for public use through the usual arrangement with local blueprinting firms. The work of preparing type maps for the counties reinventoried in the field during 1953 is about two-thirds done.

The computation of type areas and timber volumes by ownership class and timber growth and mortality was completed for Lewis County, Washington, and Clatsop and Crook Counties, Oregon. Similar work is better than half done for Deschutes, Jefferson, Wheeler, and Harney Counties, Oregon, and Kittitas County, Washington.

The analysis of timber inventories of the Douglas-fir subregion for the Timber Resource Review using the recently reinventoried counties as a base is roughly three-fourths complete.

County statistical reports presenting forest land and timber volume data resulting from the reinventory were published for Grays Harbor, Mason, Clark, Skamania, Pacific, and Lewis Counties in southwestern Washington. Generally speaking, the sawtimber volume in these counties shows an apparent increase compared to the 1931 inventories disregarding influence of changes in specifications and utilization. Lewis County is a noticeable exception for in this county sawtimber volume was found to be much less, regardless of specification changes, in the recent reinventory than in the original 1931 inventory. This is probably due to the large-scale cutting in this county, a substantial part of which was in relatively fast-growing stands. If allowances are made for changes in standards between the 1931 and the 1952 inventories, the sawtimber volume figures for all counties except Skamania either show a decrease or no appreciable increase. Skamania County on this basis shows a substantial increase in volume no matter what the basis of comparison. Little cutting had taken place in this county up to a few years ago. More detailed mapping resulting from improved techniques and accessibility gave an increase in commercial forest land area of some 8 thousand acres in the county. Also a large acreage moved from the pole-timber class into the sawtimber class. Growth has been considerable. All these factors have combined to give the greater volume now.

A firmer basis for comparing timber volume conditions in these counties is available in the growing stock figures, which include both sawtimber trees and pole-timber trees. Differences in specifications and standards of utilization are minimized in this instance. The cubic volume of growing stock (trees 5.0 inches and larger) in these six

counties--Grays Harbor, Mason, Clark, Skamania, Pacific, and Lewis--was 23,486 million cubic feet in 1931 and 21,135 million cubic feet in 1950-51. This represents a decrease of 2,351 million cubic feet or approximately 10 percent in the 20-year period. This group of counties has experienced heavy cutting during the past two decades, particularly in the old-growth stands. This normally results in reduction of growing-stock volume. In these same six counties the area of nonstocked forest land is decreasing. In 1931 there was 990 thousand acres of nonstocked commercial forest land; in 1950-51 there was 332 thousand acres. Further analysis of the forest land area data shows a definite movement towards a better balance of age classes in the past 20 years in this group of counties. Although no calculations have been made of a desirable level of growing-stock volume the area analysis provides evidence of progress toward that goal.

Work on Task V, Timber Utilization, of the Timber Resource Review, was practically completed during 1953. It included analysis of the volume and nature of logging residuals for the year 1952. Data taken in western Oregon during a field survey conducted cooperatively were analyzed and integrated with similar data for western Washington. The latter data were based on a survey made in 1949-50 by the Washington Institute of Forest Products. They were adjusted to meet 1952 conditions and Timber Resource Review specifications. Washington Forest Products Institute data for the ponderosa pine subregion of Washington were reanalyzed and field checked. From this base, data for the entire ponderosa pine subregion were developed.

A survey of mill residuals for the Timber Resource Review was done jointly by the Forest Survey and the Forest Utilization Service. It is reported in detail in that section of the report (page 55).

Cooperative Blowdown-Bark-Beetle Survey

The final report on the 1952 Blowdown and Bark-Beetle Survey was completed and published. As a followup to this survey, another cooperative project was undertaken in 1953 to determine the additional timber losses due to blowdown and the Douglas-fir bark beetle. The main purpose of the 1953 survey was to measure the changes in extent and severity of the damage as an aid to predicting the future course of the epidemic.

An estimate of the total amount of additional blowdown was obtained from field sample plots. A generalized map showing changes in the extent and severity of the beetle loss was made by aerial sketch mapping procedures. An estimate of the total amount of additional beetle loss will be obtained from the sketch maps and from aerial photographs.

In order to eliminate the need for annual sketch mapping to keep track of additional losses, a series of plots were photographed in color from the air. Rephotography of these plots in the future will provide a basis for estimating the periodic losses.

This project was done cooperatively with the Division of Forest Insect Research and is reported briefly on page 24. Personnel were contributed by Region 6 of the U. S. Forest Service, Region 1, of the Bureau of Land Management, the Oregon State Board of Forestry, and the Washington State Division of Forestry. The field work on this project has been completed but the photo interpretation and computations are still in progress.

Plans for Forest Economics in 1954

It is planned to complete all phases of the office work for Jefferson, Deschutes, Wheeler, and Harney Counties, Oregon, and Kittitas County, Washington, before April 1. The detailed inch-to-the-mile type maps for these counties will be completed and ready for release by the end of the summer.

County statistical reports scheduled for preparation and publication during 1954 are Crook, Clatsop, Deschutes, Jefferson, Wheeler, and Harney Counties in Oregon and Kittitas County in Washington. It is planned to cooperate with the Oregon Forest Products Laboratory on a publication giving the results of the cooperative field survey of logging residuals in Oregon. A report will be prepared for publication on the volume and nature of timber products output in Oregon and Washington. The publication "Forest Resources of Oregon" will be brought up to date and revised for publication in cooperation with the School of Forestry, Oregon State College, and the Oregon State Board of Forestry. It will probably be ready near the end of the year. Results of the 1953 cooperative Douglas-fir blowdown-bark-beetle survey will be published during the year.

It is planned to initiate and complete field reinventory surveys in Wasco, Hood River, and Morrow Counties, Oregon, and Klickitat, Yakima, Thurston, and Kitsap Counties, Washington. Office computations will commence for these counties at the end of the field season but will not be completed until the following year.

Timber Resource Review Task V, Timber Utilization, was completed in January as this report was being prepared. Task VI of the Review, Timber Inventory, will be completed about April 1 and Task VII, Timber Growth, a little later in the year. This work will provide up-to-date statistical summaries on the timber resources of Oregon and Washington and Douglas-fir and ponderosa pine subregions of the two States.

Greater attention is planned for research in aerial photo techniques as applied to determining forest inventories and timber mortality.

Assistance will be given the station's Division of Forest Insect Research and other cooperating agencies in additional surveys of the Douglas-fir bark-beetle epidemic as needed.

European laminating practice and experience is valuable in helping to establish confidence in the suitability and performance of our own laminated products. Our production has vastly outstripped the European, chiefly because we have larger timber resources and our economy is based to a greater extent on structural use of wood. However, we may profit by studying their approach to the design of wood members in structural shapes other than rectangular.

Kiln Drying Lumber Cut from Young-Growth Douglas-fir

During the year the station cooperated with the Oregon Forest Products Laboratory in studying the kiln drying of lumber cut from young-growth Douglas-fir timber, which is generally of small diameter. This type of tree produces practically no clear grades of lumber but does produce a very high percentage of No. 1 Common lumber. Knots, which are largely responsible for classifying the lumber in the common grades, are chiefly sound and intergrown.

Dimension cut from the old-growth Douglas-fir contains large, black, knots. These become loose and often drop out when the lumber becomes thoroughly dry. Consequently, when such lumber is seasoned it is usually kiln dried to a moisture content of 18 to 20 percent to avoid excessive knot loosening and the development of knotholes in surfacing the dry lumber. The principal objective in making this study was to explore the possibility of developing drying schedules to dry and surface the sound-knotted dimension cut from young-growth trees to a moisture content of about 12 percent without serious degrade. This would materially reduce shrinkage of the lumber when used for framing a house and would also reduce shipping weights.

Approximately 75 thousand feet of green 2x8 No. 2 Common and Better Douglas-fir of this type was kiln dried in this study. The lumber was distributed into 12 different kiln runs, most of which was dried in the experimental kiln at the Forest Products Laboratory at Corvallis, but some was dried at commercial installations. Part of the lumber was dried to a moisture content of 18-20 percent similar to the industry practice for old-growth Douglas-fir dimension. Another portion was dried to 12 percent moisture content.

Although the study is not completed, the preliminary results indicate that the sound-knotted lumber cut from young-growth Douglas-fir can be kiln dried to a moisture content of 12 percent and then satisfactorily surfaced without serious degrade. High humidity kiln schedules are required for this drying, indicating that common grades must continue to be dried separately from finish grades. Lumber for the experimental runs was graded rough-green and again after being kiln dried and surfaced. The weight of the surfaced lumber also was determined.

It is reasonable to expect that the development of suitable kiln drying schedules for such sound-knotted dimension will interest the lumber industry in kiln drying more of its output to obtain the benefit of

the premium price for dry dimension as well as to reduce the shipping weights.

Use of Mill Residuals by Pulp and Hardboard Industry

The most outstanding example of improved wood utilization continues to be the use of mill residuals in the pulp and paper industry. Recent surveys show that in 1950 the pulp and paper industry used the equivalent of 630 thousand cords of wood in the form of chips obtained from residual material at sawmills and plywood plants. In 1952, the volume had increased to 1.2 million cords. This was approximately 25 percent of the raw material used by pulp mills in this region. Volume increased again during 1953, although the increase was not as great as for the two previous years. Most of the sulfate mills, which can utilize Douglas-fir, are now obtaining close to three-fourths of their raw material in the form of chips and cannot greatly expand this use.

Sulfite pulp mills, which require non-resinous species such as hemlock and spruce, are not in as enviable a position in the use of mill residuals. Not enough hemlock and spruce is cut by sawmills; therefore, not much mill residue from these species is available for pulp. The sulfite mill companies are, however, trying to get sawmills to saw what hemlock they have separately from Douglas-fir, thus getting as much raw material from this source as possible.

Many sawmills are considering installing whole-log barkers, thereby increasing the production of pulp chips. However, the market for Douglas-fir chips is now near the saturation point and more markets are needed for this material. This region has sufficient potential raw material to support a considerable increase in the sulfate pulp capacity if other problems can be solved.

Use of mill residue by hardboard plants was greatly expanded during the year. Several new plants came into production during 1953. This region has 11 plants now operating or in the last stages of construction. These plants have an annual rated capacity of 480 million square feet of 1/8-inch hardboard. The equivalent of 160 thousand cords of wood will be utilized annually for making the hardboard and all of it will come from residuals having little or no commercial value.

Hardwood Log and Lumber Grade Study

Additional work was done during the year in developing log and lumber rules for western hardwoods. The use of hardwoods, particularly alder, continues to expand, making it more essential to have a set of rules under which the material can be bought and sold both as logs and lumber. At present there is no rule for grading logs and the local grades for hardwood lumber cannot be correlated with those used by the hardwood lumber industry elsewhere. A considerable volume of western hardwood lumber is now shipped to the Los Angeles furniture markets and sold in competition with eastern and southern hardwoods which are graded

on the national hardwood lumber rules. Therefore, it is believed that the local hardwoods should be graded and sold by the national rules.

In 1952, a cooperative project was carried on with the Oregon Forest Products Laboratory to determine if it was practical to grade the logs by rules developed for eastern and southern hardwoods and to learn if the lumber could be graded by national hardwood lumber rules. Since alder is the most plentiful species, it was first to be studied. This year Oregon maple was studied and additional data were gathered for alder. Results to date indicate that log rules developed for other hardwood species can be used for this region with minor modifications. Also, it was found that it is practical to grade the lumber by the national rules. The Oregon Forest Products Laboratory is planning to conduct a grading school to familiarize local hardwood lumber manufacturers with the national rules. Information on lumber recovery obtained from these studies indicates that the quality of lumber produced from our local hardwoods compares favorably with that obtained from hardwoods in other parts of the country.

New Logging Equipment

This region contains a large volume of timber on rocky steep ground that is inaccessible by present logging practices. Therefore, this timber has not been included in calculating allowable cuts on our national forests. There is also an additional volume of timber growing on unstable soil and in municipal watersheds that cannot be logged with customary logging equipment without excessive damage to the soil. For some time forest managers have been aware of the fact that a different type of equipment was needed before these areas could be logged.

One piece of equipment which appears to have promise is the Wyssen-Skyline-Crane developed in Switzerland. This type of equipment is in use in many countries throughout the world. One operation was inspected by personnel of this station at British Columbia where it has been in operation for the last two years. Recently negotiations were started to try this equipment in the steep, rocky ground in the pine type of central Washington. It now appears that one or two of these machines will be in operation in this area during the summer of 1954.

Peeler Log-Grade Study

During the year the Madison Laboratory released Progress Report No. 3 as part of the long-time study to develop information to assist in grading logs. This report consists of a set of guides for grading logs by their outward appearance rather than estimating the type of veneer they will produce, which is the basis for the present rules now being used by the log scaling and grading bureaus. In order to test the practicability of the Laboratory's specifications a study was made during the summer at a plywood plant in Oregon. Thirty-five logs were carefully graded by the Laboratory's rules and then by representatives from each of the scaling bureaus, using their rules. The logs were then followed

through the plywood plant and the volume and grade of veneer by logs was recorded behind the dryer. This study and the data obtained were of considerable assistance in improved grading of peeler logs regardless of the rules used.

Small Sawmill Study

It is estimated that between one-fourth and one-third of the lumber cut in the Douglas-fir region is from second-growth timber which is usually of small size. Mills used for cutting old-growth timber have been found to be relatively inefficient for second-growth and there have been many developments in small sawmills which have greatly increased the output per man-day. During the summer two men from the Forest Products Laboratory in Madison made a study of the newer developments in sawmills in this region. Information was obtained on plant investment, output per man-day, carriage-feed rates for different size logs, and overrun and grade of lumber produced. Studies were made at a permanent round-log gang mill, a portable round-log gang, and at two types of Skragg mills. These latter mills are a new development in this region, consisting of two saws on one mandrel. They are adjusted for the various size logs much the same as the system used in an edger. The Skragg mills have proven to be very efficient for the production of 8-foot studs. Data obtained in this study are now being compiled at the Forest Products Laboratory.

Paper-Faced Veneer for Containers

A new wood shook material produced in the Pacific Northwest has been made available to the container industry. A single thickness of wood veneer with one thickness of kraft paper glued to each face came into production in this region during the year. Paper-faced hardwood veneer has been produced in the South for a number of years and a major part of the production has been used for container purposes.

In this region sawed lumber has been the preferred container material, although there has been a limited amount of softwood veneer used for the lighter parts of fruit and vegetable containers. Laboratory tests have shown that kraft paper glued to the faces of veneer will add considerable bending strength, stiffness, and resistance to nail splitting. Consequently, the strength furnished by the wood is less important and lower-quality veneer can be utilized. Hence it is not necessary to use veneer suitable for face plies in plywood.

During the past year two plants began producing paper-faced veneer in this region. Rotary cut 1/8- and 1/10-inch white fir and white-pocket Douglas-fir are being used. This type of an operation lends itself to integration with a plywood operation. The Forest Products Laboratory and this station have taken an active part in the development of paper-faced veneer. It is expected that many new markets will be developed for this product.

Plans for Forest Utilization Service in 1954

Work of the Forest Utilization Service for the coming year will continue much the same as in the past. Working relations between industry and the Forest Products Laboratory and other institutions doing research in wood utilization will be maintained as in the past. A variety of projects will be worked on but major emphasis will be given to the following projects:

1. Lumber grade recovery studies for all species in the ponderosa pine type.

2. Kiln drying of lumber, particularly that produced from second-growth Douglas-fir.

3. Utilization of western hardwoods for pulp, lumber, and other products.

4. Improvements in methods and equipment for logging and primary manufacture.

5. Utilization of mill residues for the production of pulp and hardboard.

6. Utilization of white-pocket Douglas-fir for the production of paper-faced veneer and similar products.

7. Laminating and uses for laminated products.

8. The effects of growth conditions on wood quality and the relation of wood structure to its properties.

9. Utilization of "associated species" for fruit and vegetable containers. Study of other materials suitable for containers such as plyveneer or container board.

PUBLICATIONS

Outside Publications

Cowlin, R. W. Vertical integration in forest-products firms. In W. A. Duerr and H. J. Vaux "Research in the Economics of Forestry," pp. 324-329.

Describes the research approach to a representative problem in the field of forest economics.

Driscoll, R. S. Use plastic to protect aerial photographs. Jour. Range Mgt. 6 (3): 181-182. May 1953.

Describes a simple method of applying plastic spray on aerial photographs for field use. Stereoscopic work is not hindered and additional markings may be placed on the photograph and fixed by another layer of spray. The plastic coating may be removed with solvent.

Dunford, E. G. Review of "Climate, Vegetation and Man" by Leonard Hadlow. Jour. Forestry 51 (12): 912-913. Dec. 1953.

Describes the author's treatment of worldwide climate and its effect on human and plant ecology.

Garrison, G. A. Annual fluctuation in production of some eastern Oregon and Washington shrubs. Jour. Range Mgt. 6 (2): 117-121. March 1953.

Biotic and climatic factors reduced browse production to one-third to one-fifth of production in other years for antelope bitterbrush, snowbush ceanothus, rubber rabbitbrush, creambush rockspirea, and big whortleberry. These fluctuations should be considered in grazing management for eastern Oregon and Washington shrub ranges.

Garrison, G. A. Effects of clipping on some range shrubs. Jour. Range Mgt. 6 (5): 309-317. Sept. 1953.

Various methods of clipping eastern Oregon and Washington shrubs stimulated twig production to the detriment of flower and fruit production. Vitality decreased under heavy clipping. Levels of use for sustained shrub production are suggested for five shrubs on different winter range sites.

Harris, R. W. Quicker, easier way to make trough shown. Oregon Cattleman 1 (12): 8-9. April 1953.

A five-step procedure for constructing water troughs with a one-man chain saw is described. The method greatly

reduces the hewing labor. Directions for selected suitable trees are given.

Hayes, G. L. and Marburg, T. F. Optimum intensity of protection from forest fires. In W. A. Duerr and H. J. Vaux "Research in the Economics of Forestry," pp. 98-105.

Gives a procedure for determining economic optimum intensity of protection from forest fires for any specific forest area. The method is readily applied wherever good cost-and-loss figures for fire control are available.

Isaac, L. A. Impressions of European forestry. Western Conservation Journal 10 (6): 16-17, 38-39. Nov.-Dec. 1953.

Observations of forestry activities and methods in western European countries with emphasis on the planting of Pacific Northwest conifers.

Johnson, F. A. Mortality studies in young fir plots show great annual wood losses. Lumberman 80 (7): 146. June 1953.

Annual losses in well-stocked Douglas-fir stands average 83 cubic feet or 284 board feet per acre. Based on data from 37 permanent sample plots established over a period of 40 years.

Johnson, F. A. and Carmean, W. H. Sampling error in the estimation of site index. Jour. Forestry 51: 26-27. Jan. 1953.

Large errors in estimates of growth and volume can result from basing site index determinations on too few samples. Tables showing variation among trees as site indicators are presented.

Matson, E. E. Potential raw material supply for wood fiber products. Forest Products Res. Soc. Jour. 3 (5): 142-145. Dec. 1953.

Discusses the volume and uses for logging and milling residues in the United States.

Matson, E. E. Lumber recovery from various grades of Douglas fir logs. Western Forest Industries Assoc., Vancouver, B. C. March 7, 1953. 4 pp., mimeo.

Summarizes results of several studies on lumber quality obtained from various grades of Douglas-fir logs.

Morris, W. G. Fuel moisture indicator stick as guide for slash burning. Timberman 54 (10): 128. Aug. 1953.

Comparison of moisture content of fuel sticks in open slash and nearly green timber can be used as a helpful guide in selecting a favorable time to burn Douglas-fir slash.

Sartz, R. S. Soil erosion on a fire-denuded forest area in the Douglas-fir region. Jour. Soil & Water Conservation 8 (6): 279-281. Nov. 1953.

Reports on a study of a burned area near Portland, Oregon, to determine how much erosion can be expected under a set of conditions commonly found west of the Cascades.

Shaw, E. W. U. S. foresters study effects of thinning on stands of Douglas fir. Seattle Times, Sunday, May 10, 1953.

A pictorial story of commercial thinning studies on the Voight Creek Experimental Forest near Orting, Washington.

Staebler, G. R. Long logs or short logs with the Scribner scale. Timberman 54 (10): 66, 68, 70. Aug. 1953.

Increase in scaled volume resulting when long logs are bucked and scaled as two short logs are given in a table and discussed.

Steele, R. W. Thirty years of natural regeneration on a Douglas-fir cutover area. Jour. Forestry 51: 430-431. June 1953.

Reports the progress of natural regeneration on a double transect of plots crossing the cutover portion of Wind River Valley, Washington.

Multilithed Reports

Cramer, O. P. Fire weather in western Oregon and western Washington in 1952 compared with other years. 11 pp. July 1953. (Research Note no. 86)

Reports burning conditions based on three criteria: (1) Burning index, a numerical rating indicating rate of spread expected in fine forest fuels. (2) Average number of days since a wetting rain. (3) Total number of rainless days.

Cramer, O.P. 1952 midsummer fuel moistures in Oregon and Washington national forests compared with other years. 3 pp. June 1953. (Research Note no. 85)

Gives regional ratings of midsummer fuel moisture based on weights of standard indicator sticks.

Cramer, O. P. Forest fire danger in western Oregon and Washington during 1953. 5 pp. Nov. 1953. (Research Note no. 94)

Fire weather in 1953 for both western Oregon and Washington was below normal severity. The 1953 season is compared with 1952 and the 10-year average of 1944 through 1953 seasons.

Eversole, K. R. Better marking means cheaper pruning. 4 pp. July 1953. (Research Note no. 87)

Selection of "Run-of-the-mill" dominants and codominants can result in pruning trees which later drop to lower vigor classes. In even-aged Douglas-fir stands only well-formed dominants should be pruned.

Greeley, A. W., Wright, K. H. and Pope, R. B. Final report on the 1952 blowdown-bark beetle survey in the Douglas-fir region of Oregon and Washington. 30, A33 pp. illus. July 1953.

A detailed account of the planning, conduct, and results of a cooperative aerial and ground survey in 1952 to detect and evaluate catastrophic damage by blowdown and the Douglas-fir beetle. Acreage and volume estimates of the damage by counties and ownership classes are included.

Knauss, A. C. Utilization of mill residues in the timber products mills of the Lakeview working circle. 14 pp. June 1953. (Research Paper no. 6)

Evaluates the volume of mill residuals developed in the manufacture of lumber in the Lakeview working circle.

Moravets, F. L. Forest statistics for Skamania County, Washington. 23 pp. Jan. 1953. (Forest Survey Report no. 107)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Skamania County.

Moravets, F. L. Forest statistics for Clark County, Washington. 25 pp. April 1953. (Forest Survey Report no. 108)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Clark County.

Moravets, F. L. Forest statistics for Pacific County, Washington. 25 pp. June 1953. (Forest Survey Report no. 109)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Pacific County.

Moravets, F. L. Forest statistics for Mason County, Washington. 24 pp. July 1953. (Forest Survey Report no. 110)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Mason County.

Moravets, F. L. Forest statistics for Grays Harbor County, Washington. 24 pp. August 1953. (Forest Survey Report no. 111)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Grays Harbor County.

Moravets, F. L. Forest statistics for Lewis County, Washington. 24 pp. Nov. 1953. (Forest Survey Report no. 112)

Summarizes in statistical form timber volume and forest land area data resulting from reinventory of Lewis County.

Mowat, E. L. Thinning ponderosa pine in the Pacific Northwest; a summary of present information. 24 pp. June 1953. (Research Paper no. 5)

Summarizes information showing that improved growth of ponderosa pine results from thinning. Diameter growth of crop trees can be increased 30 to 150 percent and heights by a lesser amount through premerchantable thinnings.

Roth, L. F. Pine dwarfmistletoe on the Pringle Falls Experimental Forest. 3 pp. Nov. 1953. (Research Note no. 91)

The relationship between mistletoe in overstory crowns and its intensity and distribution in the surrounding regeneration is explored.

Ruth, R. H. and Yoder, R. A. Reducing wind damage in the forests of the Oregon Coast Range. 30 pp. illus. July 1953. (Research Paper no. 7)

A progress report on a study to determine the best methods of managing coastal forests to minimize wind damage and to provide for efficient salvage of nonpreventable losses. Describes characteristics of damage observed and suggests cutting practices to minimize losses from storm winds.

Ruth, R. H. Survival and growth of fresh and stored planting stock. 2 pp. Nov. 1953. (Research Note no. 93)

Douglas-fir and Port-Orford-cedar seedlings were planted near Waldport, Oregon. Growth and survival over a ten-year period shows that planting stock stored for two months prior to planting survived and grew as well as freshly dug stock.

Shaw, E. W. Direct seeding experiments on the 1951 Forks Burn. 19 pp. illus. Dec. 1953. (Research Paper no. 9)

A case study of the relative suitability of Douglas-fir, Sitka spruce, western hemlock, and Port-Orford-cedar for helicopter seeding in northwest Washington. Suggestions for improving direct seeding studies are given.

Shaw, E. W. Effects of tetramine used for rodent control in direct seeding of Douglas-fir. 7 pp. Aug. 1953. (Research Note no. 89)

A field test on a 100-acre tract near Olympia, Washington, shows that tetramine is effective in preventing rodent damage.

Silen, R. R., and Gratkowski, H. J. An estimate of the amount of road in the staggered-setting system of clearcutting. 4 pp. Nov. 1953. (Research Note no. 92)

Measurements on the H. J. Andrews Experimental Forest show that 8.8 percent of the total forest area is disturbed by road-building and an additional 3.6 percent in the construction of landings. Resultant loss of production is estimated to be 2.9 percent and 1.2 percent, respectively.

Sowder, J. E. Lumber grade recovery from young ponderosa pine. 2 pp. Aug. 1953. (Research Note no. 88)

Young ponderosa pine at age of 105 years produces a good grade of common lumber but no select or clear material. Close-grown trees produce better grades than open-grown trees.

Staebler, G. R. Mortality estimation in fully stocked stands of young-growth Douglas-fir. 8 pp. June 1953. (Research Paper no. 4)

Two equations for estimating percent mortality are given, one for dominants and codominants and the second for intermediate and suppressed trees. Independent variables are d.b.h., age of stand, stocking and site index. Solutions of the equations are presented in tabular form together with a sample of the calculation procedure.

Tarrant, R. F. Effect of heat on soil color and pH of two forest soils. 5 pp. Oct. 1953. (Research Note no. 90)

Samples of two soils were heated at three temperatures, and the resultant colors recorded in tabular form according to standard nomenclature and soil reaction in numerical pH indices.

Tarrant, R. F. Soil moisture and the distribution of lodgepole and ponderosa pine; a review of the literature. 10 pp. August 1953. (Research Paper no. 8)

A summary of published information on the effect of soil moisture on lodgepole pine-ponderosa pine occurrence.

U. S. Forest Serv., Pacific Northwest Forest & Range Expt. Sta. Annual report - 1952. 57 pp. March 1953.

Describes the significant research accomplishments of the station during 1952 and briefly announces program for 1953.

U. S. Forest Serv., Pacific Northwest Forest & Range Expt. Sta. List of publications for the years 1938 through 1952. 26 pp. Jan. 1953.

A list showing title of publication, author, date of issue, publication series and number, or medium and availability.

U. S. Forest Serv., Pacific Northwest Forest & Range Expt. Sta. Volume tables for permanent sample plots as recommended by the Puget Sound Research Center Advisory Committee for use in western Washington. 28 tables. June 1953.

A compilation of total height volume tables applicable to the commercially important species of the Puget Sound region.

Worthington, N. P. Reproduction following small group cuttings in virgin Douglas-fir. 5 pp. April 1953. (Research Note no. 84)

Regeneration following small group cuttings is compared with regeneration on a large clearcutting.

DIVISION OF FOREST INSECT RESEARCH[1/]

Processed Reports

Buckhorn, W. J., and Berry, D. The La Grande experimental spruce budworm control project, season of 1951. 10 pp. Feb. 1953.

A report on large-scale experiments with reduced application of DDT. Application below one pound per acre did not give satisfactory control.

Coulter, W. K. Studies of the biology and control of the spruce budworm in Oregon and Washington - 1952. 17 pp. April 1953.

This annual report of a long-term study shows that the budworm outbreak is continuing on unsprayed areas despite natural control and that one application of DDT gives effective control for three or more years.

Coulter, W. K., and Hunt, J. Pseudohylesinus bark beetles in silver fir in the State of Washington, 1949-1952. 24 pp. August 1953. (Cooperative report with the University of Washington.)

This report summarizes a 3-year, cooperative study that was undertaken in 1949 to determine the nature and causes of a silver fir beetle outbreak and to investigate the possibilities of control.

Hutchison, F. T. An aerial appraisal of black-headed budworm damage on selected areas of the Tongass National Forest. 7 pp. Sept. 1953.

Western hemlock damage caused by repeated budworm feeding was mapped on the Ketchikan Pulp Company sale area and adjacent timber stands. Serious top killing was concentrated on 20,000 acres. Timber volumes associated with this top kill are tabulated and survey procedure outlined.

McCambridge, W. F. The black-headed budworm survey on the Tongass National Forest, Alaska, season of 1953. 15 pp. Oct. 1953.

Defoliation of western hemlock caused by the black-headed budworm extends over 16 million acres of the Tongass National Forest. Repeated defoliation for several years has resulted in extensive top killing of hemlock. Parasites and disease are exerting strong control pressures. Initial biological studies and artificial control investigations are discussed.

U. S. Bureau of Entomology and Plant Quarantine, Forest Insect Laboratory. An evaluation of forest insect and disease research needs in Oregon and Washington, Part I, Insects. 27 pp. Nov. 1953. (Advisory to Northwest Forest Pest Action Committee)

A summary of forest pest research needs stressing research to be undertaken, and methods of implementing, coordinating, and disseminating results of the proposed research.

U. S. Bureau of Entomology and Plant Quarantine, Forest Insect Laboratory. Report of forest insect surveys in Oregon and Washington, season of 1953. Portland, Oreg., Oct. 1953. 36 pp. (Cooperative report with Oregon State Board of Forestry)

An account of the principal forest insect outbreaks in Oregon and Washington in 1953.

Whiteside, J. M. Statement on spruce budworm mortality obtained during the 1953 Oregon Spruce Budworm Control Project. 7 pp., 2 tables. August 1953.

The results of the 1953 spruce budworm control project, the fifth undertaken since 1949, compared favorably with the results obtained during previous projects. Aerial spraying with DDT at the rate of one pound per acre on 369,171 acres in 1953 produced budworm mortality ranging from 88.5 to 100 percent on individual spray blocks and control units and a project average of 99.1 percent.

Wright, K. H., and Carolin, V. M. (New Haven Laboratory) Studies of the biology and control of the spruce budworm in Oregon and Washington - 1951. 30 pp. illus. April 1953.

A description of study methods and results of investigations of the habits and natural control of the spruce budworm. A determination of the abundance of natural parasites of the budworm on sprayed areas as compared to non-sprayed areas is of special significance.

DIVISION OF FOREST DISEASE RESEARCH[1/]

Childs, T. W., and Clark, J. W. Decay of wind-thrown timber in western Washington and northwestern Oregon. 20 pp. Sept. 1953. (U.S. Dept. Agric. Forest Pathology Special Release no. 40)

Curves and tables show rate of decay of windthrown Douglas-fir, Sitka spruce, western hemlock, and Pacific silver fir in four localities. Methods are described for predicting rates of decay in timber windthrown in other localities.

1/ Published prior to reorganization of the Department of Agriculture while these divisions were under the Bureau of Entomology and Plant Quarantine and the Bureau of Plant Industry, Soils, and Agricultural Engineering, respectively.